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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
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Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Events.

Institute of British Foundrymen.

JANUARY 1.

London Branch (Junior Section):—Ordinary meeting at 49, Wellington Street, London, W.C.2. Paper by A. B. Everest, Ph.D., B.Sc.

JANUARY 8.

Middlesbrough Branch:—Ordinary meeting. "The Combining of Metallurgical Knowledge with Practical Foundry Training," Paper by H. Foster.

JANUARY 9.

East Midlands Branch (Lincolnshire Section):—Ordinary meeting at Lincoln. "Oil-Sand Cores," Paper by B. Gale.

Lancashire Branch:—Ordinary meeting at Manchester. "Sand-Slinging Practice in the Foundry," Paper by A. J. S. Shewan and J. Atchison.

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "Balancing the Elements," Paper by F. J. Cook (Past-President of the Institute).

West Riding of Yorkshire Branch:—Annual dinner.

Chilled Rolls.

The roll trade has noted with interest two Papers on the causes of roll breakage recently presented to the South Wales Institute of Engineers by Mr. J. S. Caswell and Prof. F. Bacon. A Paper given by the latter to the Staffordshire Iron and Steel Institute has also recently been issued. It is pointed out that it is more important to get the best possible quality than to get an average quality at a lower cost, for the cost of a breakage is not merely the cost of the roll (in itself no light matter), but the consequential loss of output while replacement is being effected.

It is said that in the tinplate industry alone roll breakage costs the industry £200,000 a year, and that in the sheet and galvanising mills the cost of rolls is 5s. a ton on the cost of the product. There can be no doubt that roll breakage not only causes considerable financial loss, but a certain amount of mental wear and tear between the maker and user in settling the always vexed question of responsibility.

One of the great difficulties in the way of improvement is the scale on which trials have to be conducted. This and the cost of replacement and loss of output it involves make the industry disinclined to take any chances. These chances, however, have to be taken if more rapid progress is to be made, and it appears a suitable job for tackling on a co-operative basis by the makers concerned.

These Papers serve to illustrate the very great value to the industry of the provincial engineering institutions, for they permit a slightly less formal type of Paper than the national bodies, and in the provinces, too, discussion is apt to be less discussive and more directly concerned with the subject at issue. In South Wales several meetings have been devoted to this matter, as the widening interest in the original work produced more contributions to the discussion. They also serve to illustrate how rapidly an apparently academic aspect for subject may become of commercial importance. Two years ago the fatigue strength of cast iron would have been regarded as much too remote for everyday practice to justify any time or attention. On the publication of these Papers it became a live subject, and all the available information on it was eagerly sought. Testing white iron, however, is by no means a simple matter, and the whole thing shows how important it is not to have too rigid a regard for commercial utility of an immediate kind in doing research and experimental work. Altogether the Papers here stimulated very useful discussion on chilled rolls at a time when the subject was regarded as one on which little more could be said, and hence they have served a very useful purpose.

The Hyphenated Foundrymen.

In preparing for Press an authoritative article by Prof. Dr. Pisek, we learnt that the value of the output of castings in that country is over £3,000,000 per annum. Both Mr. Pearce, director of the British Cast Iron Research Association, and ourselves have tried to evaluate a similar figure for Great Britain. We have arrived at a figure of £26,000,000 as its normal annual buying capacity. Obviously this is only an approximation, which has taken into consideration foundry pig-iron production, export and import statistics, number of foundry concerns and departments, capital expenditure on equipment for new plants, alloy purchases for the steel and non-ferrous trades. Taking the production costs in Czecho-Slovakia as a basis, we find that 550 foundries produced £3,000,000 worth of castings, which value under normal British conditions would reach £5,000,000. Then there are at least 12 times as many foundries in Great Britain, which would make our figure in the region of £60,000,000—truly a colossal figure. Yet because of its subdivisions and incompatibility of interests, we possess no statistics officially calculated for the industry as a whole. Conditions are still such that a majority of castings manufacturers still regard themselves as something quite different, such as mechanical, electrical and other hyphenated engineers, C.M.E.'s, manufacturers of stoves, of weighing machines, of pipe, of pumps, of mangles, of machinery of every description. Could they but be made to realise that they are also hyphenated founders and as such there was a community of interest to be cultivated, the industry would rapidly assume the political and industrial importance it well merits. Only last year one of Britain's greatest industrial magnates confessed to us that he had learnt with great interest and surprise that he was ranked amongst the largest foundry owners in the south of England. It is a matter of the highest importance that whilst other countries are proud of their foundry industry, yet there still remains a large section of our industrial leaders which deliberately refuses to acknowledge its identity with this important section of its activities. How many of the prominent names associated with textile, marine, printers', agricultural implement and general engineers are household words in the foundry industry? Actually it is a deplorable low percentage. The total of the people organised within the purely foundry employers' organisations and the research and technical institutes would not equal the number of the attached and detached foundries of Great Britain and Northern Ireland.

Notes from I.B.F. Branches.

Scottish Branch.—A meeting was held in the Royal Technical College, Glasgow, on December 12. Mr. N. McManus, M.B.E. (Branch-President) occupied the chair, and was supported by Mr. A. Harley, President, and Mr. T. Makemson, general secretary, of the Institute, who were paying the annual visit to the Branch.

The Chairman said that since the last meeting death had removed two persons who had been intimately associated with the Branch since its inception, namely, Mr. John King, who was their first President, and Sir Archibald McInnes Shaw. Sir Archibald had done much service to them, and it was his influence which helped them when occasion arose for approaching the Corporation. He himself had not had the pleasure of knowing either of these gentlemen personally, so he proposed to ask Mr. Campion, who had been associated with them, to make a few remarks.

Mr. A. Campion said that time did not permit him to say all that might be said about the services of Bailie King and Sir Archibald to the Institute and to the Scottish Branch in particular. It had been his pleasure to have been associated with Bailie King in the early days of the Branch, and could testify to the hard work which he did for it, and it was in no small measure due to his enthusiasm and influence that the Branch was established on that sure foundation which had enabled it to be built up to its present position. In recent years ill health had prevented Bailie King from taking an active part in the work of the Branch or of attending meetings, but he had never lost his interest in its work, and at any time that he had been in conversation with him he had been anxious to learn of the Branch's progress. He had repeatedly spoken of the advantages of membership for all connected with the industry.

Sir Archibald McInnes Shaw was asked to become the first President when the Branch was formed, but as he at the time occupied the position of Lord Provost of the city, he felt unable to accept office. He promised that he would give all possible assistance and support to the Branch, a promise which he had invariably fulfilled. It was giving no secrets away to say that he was the main key to the Corporation when application was made for receptions or recognition upon the occasion of annual conventions held in Glasgow or the entertainment of overseas visitors. When the Branch had the honour of entertaining the overseas delegates to the international congress, during the preconvention tour in 1929 Sir Archibald acted as chief host and received the delegates on behalf of the Scottish reception committee. It was pleasing to think that upon the occasion of the Branch 21st birthday celebrations they were able to perpetuate Sir Archibald's work for the industry and the city by founding the prize which bears his name for foundry students. The Branch was represented at the funeral by Mr. T. P. Cameron.

Although the chairman had not mentioned it, there was yet a third person who had passed away since the last meeting, one who perhaps was better known to many in the room than the other two, Mr. Robert C. Crawford, president of the Atlas Company of Detroit, U.S.A. He, although not a member of the Institute, was a native of Glasgow, and known to many local foundrymen. He always took a great interest in the affairs of the Scottish Branch. He was one of the delegates in 1929, and many in the room would have pleasant recollections of his enthusiasm and humour. Mr. Crawford sent greetings on his own behalf and also on behalf of the Detroit Foundrymen's Association on the attainment of the 21st birthday. The secretary had already submitted resolutions of sympathy on behalf of the members to the relatives of all three deceased, and he asked them to confirm by standing in silence for a few moments.

The Chairman said that they had with them Mr. Andrew Harley, the President of the Institute, and also Mr. Makemson, the secretary, and on behalf of the members he extended to them a hearty welcome. They were fortunate in that each year they had an opportunity of welcoming the President and secretary at that meeting. Later on he hoped that both gentlemen would address them.

Mr. McManus then said that they were fortunate in having with them Mr. H. Gardner, of Kilmarnock, who had kindly consented to read to them a Paper on "An Engineer's View of the Foundry." Mr. Gardner was associated with a large engineering firm of world-wide renown, who had also a large foundry department. He was therefore in a favourable position to express an opinion, and now asked Mr. Gardner to read his Paper. This will be printed in our next issue.

A meeting of the *Lancashire Junior Section* of the Institute was held in the Manchester College of Technology on December 19, when five members contributed to a "Short Paper Competition," in which two prizes were offered. The merits of the contributions will be considered by several of the Branch members, of whom Mr. J. S. G. Primrose and Mr. R. A. Brown were present. Mr. H. V. Grundy, the chairman of the Junior Section, presided.

The authors did not restrict themselves to the text of their manuscript, and they used sketches and diagrams freely. Mostly they described a foundry operation of which they had practical experience. Mr. B. Haigh's theme was the moulding of a yoke made up of a circular body and a ring or flange at each side. There are four feet on which the yoke stands for moulding; the pattern must be split in order to be withdrawn from the mould. Next, Mr. W. Foden showed how a half condenser shell is made. He began with the foundation plate and followed the construction throughout, seating, dummy and coping. "Moulding a Pan of Strickles" was the title of Mr. E. Flower's Paper. He said he had been in the industry about 18 months, and this was a job which came into the foundry a few weeks before he prepared the Paper. He had not seen anything of the sort before and was much interested in the method adopted. The casting was 6 ft. dia. and 2½ ft. deep.

Mr. W. Potts treated his subject, "Venting and Drying," more generally. He observed that if the troubles arising from these two operations were eliminated the anxieties of foundry foremen would be considerably reduced; they caused a large number of defective castings and insufficient attention was given to them. Venting was necessary to allow a quick release of the gases; the design of some patterns and core boxes made it very difficult to get gas away. Therefore, he suggested if the draftsman got a little more knowledge of the moulder's difficulties he would not design such intricate castings. In every foundry castings were scrapped through the vents being used insufficiently. More could be learned from one defective casting than from ten good ones. Mr. J. Holmes dealt with permanent moulding and die casting. He classified the subject in two main divisions: pressure die casting and gravity die casting. Pressure casting he treated under the two headings of plunge pressure and air pressure. Gravity casting was the most common form and was used for all types of alloys.

In moving a vote of thanks to the authors, Mr. J. S. G. Primrose said the result would be communicated to the secretary before the next meeting.

Messrs. Hughes, Bolchow & Company, Limited, Blyth, have purchased the Union Castle liner "Walmer Castle" for breaking up.

Random Shots.

No one, unless it be, perhaps, the brokers men, will regret the passing of 1931. We held no great expectations of it; we had no fond illusions of a boom materialising in the past twelve months; and in that respect it has not surprised us. Yet it has been a memorable year. It should figure large in the unwritten history of world economics.

* * *

"Marksman" has little confidence in prediction—least of all in the mysterious "Old Moore's" gauzy forecasts. Beyond saying that in 1932 we shall be at least one year nearer a trade revival he is not prepared publicly to go. But if you have any particular yearning to peer into the months ahead, "Marksman" is quite willing to do his best, and on receipt of a remittance will send you by return of post in a sealed envelope authoritative business tips for 1932, straight from the economist's table so to speak.

* * *

Albert was entrusted by his wife on Christmas morning to decorate the homestead with holly. But when she asked him "to set sprigs" all round the pictures, he objected, saying it sounded too much like work.

* * *

There's generally, in "Bradley's Magazine," at least one good story about the trade. In the Christmas number I noticed two, both of which I reproduce below.

In an examination one of the questions was, "Define a bolt and nut, and explain the difference, if any." One candidate wrote: "A bolt is a thing like a stick of hard metal, such as iron, with a square lump on one end and a lot of scratching wound about the other end. A nut is similar to the bolt only just the opposite, being a hole in a chunk of iron sawed off short, with wrinkles around the inside of the hole."

* * *

A newspaper, offering a guinea each for "embarrassing moment" letters, received the following epistle:—"I work on an early night shift in a steel plant. I got home an hour early last night and there I found another man kissing my wife. I was very much embarrassed. Please send me two guineas as my wife also was embarrassed." The Editor, so we are told, sent a cheque for three guineas, admitting the possibility that the stranger, too, might have been embarrassed.

* * *

(To me, personally, that last sentence doesn't seem quite natural—for an Editor.)

Marksman.

We have Received:—

Diaries.

H. G. Sommerfield, Limited, Charterhouse Chambers, Charterhouse Square, London, E.C.1, a week to the page desk diary. **Demag Aktiengesellschaft, Duisburg, Germany**, refill for desk engagement diary. **Clay Cross Company, Limited, Clay Cross, Chesterfield,** waistcoat-pocket diary containing matter of both historical and foundry technical interest. **British and Continental Traders, Limited, Astor House, Aldwych, London, W.C.2,** a hip-pocket diary specially compiled for the use of the foundry and allied trades. **John G. Stern & Company, Limited, Bonnybridge,** a vest-pocket diary containing much data of use to the users of refractory materials. **The Stanton Ironworks, Limited, near Nottingham,** a pocket diary containing 72 pages of valuable technical data. **The General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2,** a pocket diary which contains a list of electrical and allied institutions except those connected with the foundry industry.

We heartily reciprocate the good wishes accompanying these gifts.

XUM

Alloyed Cast Iron.

PRACTICAL RESULTS BECOMING AVAILABLE.

This subject has been particularly prominent in the minds of foundrymen this autumn. It has been dealt with by Mr. J. E. Hurst at Sheffield, Mr. T. R. Twigger at Coventry and Mr. Gerald Bell at Manchester. The opinions gained from these three centres, taken in conjunction with the Papers already printed, form a veritable text-book on the potentialities of alloyed cast iron. At Coventry the discussion was opened by MR. HALL, who, in seconding a vote of thanks proposed to the lecturer (Mr. T. R. Twigger) by MR. EDWARDS, asked whether, if he were casting an alloy material, would he use a hematite base; he was a believer in the inherent or hereditary properties of cast iron. Further, was it necessary when alloying nickel and chromium to limit phosphorus to a low percentage? Mr. Hall mentioned, regarding alloy irons, that in analysing a number of cylinders recently, he found the chromium was only 0.1 per cent., which suggested a desire for obtaining a higher price rather than increased wear.

Inherent Properties and Alloying.

MR. TWIGGER replied that the question of hematite versus refined irons brought up straight away a consideration of inherent properties. He believed there was probably something in the view that refined irons or high steel mixtures did not give the same results as regards resistance to wear as could be obtained with some of the more normal types of foundry irons. While the enormous increase in recent years in cylinder wear was due to some extent to the severity of modern conditions—higher speeds, higher pressures and so on—he was not sure that some of this wear was not aggravated by the use of high percentage steel mixtures. As to using a low-phosphorus base when adding nickel to chromium, he did not think those alloys made any difference to the most desirable phosphorus content. For most classes of work a much lower phosphorus was used to-day compared with a few years ago. Nickel or chromium produced their several effects, irrespective of the phosphorus content within the limits usually met with. With regard to the cylinder block of "chromium" iron, which contained only 0.1 per cent. chromium, it was not uncommon to find 0.1 per cent., or even more, in ordinary iron. In some cases where his firm desired a low chromium it came unexpectedly high, and they had found it advisable to start analysing quite ordinary types of iron, which often showed an appreciable percentage of chromium. Therefore it was possible that the particular cylinders referred to had no extra chromium added.

Alloy Additions and Shrinkage Stresses.

MR. EDWARDS, remarking that nickel in conjunction with chromium was sometimes employed to render a complicated design less noxious, asked could Mr. Twigger suggest the percentages of those alloys necessary to prevent shrinkage stresses in castings. He cited a case where the walls of a casting varied in thickness from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. and $\frac{3}{4}$ in. and these thicknesses were in close juxtaposition. If these shrinkage stresses could be overcome in such castings as ordinary designers sent to the foundry, both in steel and iron, then the industry would have arrived at a very satisfactory state of development. Many designers seemed to think a moulder could make anything, but they could not emphasise too much that foundries much preferred an even design and uniform sections than to dabble with an heterogeneous composition. He noticed there was some difference in the test results on tempered and untempered cast iron compared with the investigations of Mr. Hurst and asked would the fact of the pearlite structure replaced in the as-cast condition by the martensitic structure on hardening explain the difference in the strength. Regarding the wear of a riveted brake drum, it would be interesting to note what happened when a brake drum was in service without rivets. It was very interesting indeed to hear that cast iron had a considerably longer life than steel for this particular purpose.

Shrinkage Unaffected.

In reply MR. TWIGGER said the element that would prevent shrinkage stresses in castings having divergent sections in juxtaposition did not appear to have so far been discovered. He did not think nickel and chromium made any difference to shrinkage stresses, which would always be present in uneven and irregular designs, but they did to some extent enable one to produce a denser casting with more even grain, thus keeping the thicker sections sound with the thin sections still machinable.

While there was some difference in elasticity values in the results obtained by Mr. Hurst and himself they agreed as to the drop in strength on hardening and recovery on tempering. He was not questioning Mr. Hurst's results in the least. The difference was probably accounted for by the difference in test procedure.

It was undoubtedly the replacement of the pearlitic structure by martensite together with probably troosite and sorbite in the tempered samples which accounted for the increase in hardness, and in the case of sufficiently tempered samples the increase in strength over the as-cast material as the graphitic carbon was not removed by the hardening process. On the score of safety first many people favoured securing the brake liners in the drums with rivets. They had both aluminium and steel drums with cast-iron liners secured solely by an interference fit which were shortly to undergo stringent tests.

Effect of Chromium.

MR. WRIGHT inquired was not the increased resistance to wear and heat in chromium iron due to the effect of chromium on the state of the carbon. In his foundry chromium had been used; not to any great extent, perhaps 0.3 per cent. or so, in irons containing 3.3 per cent. total carbon—the combined carbon being just under 1 per cent.—with normal sulphur and fairly low phosphorus. In a polished specimen magnified to quite a low degree, perhaps to 50 or 60 diameters, they found that the graphite appeared to be broken up into very thin flakes. This in itself might account for the special qualities of the iron as regards heat- and wear-resisting properties.

Improved Quality Ascribed to Close Grain and Finely Divided Graphite.

MR. TWIGGER replied that generally chromium ensured a closer grain; it made for finely divided graphite flakes initially, which was no doubt an advantage as regards resistance to heat. Chromium also stabilised the carbide under heat, so that the pearlite decomposed less rapidly into ferrite and graphite.

Phosphorus Content and Wear.

MR. NEATH, alluding to the fairly high phosphorus content used in former years, now displaced in practice by a low percentage, asked how much the lower phosphorus in cylinder irons was responsible for increased wear. He mentioned that there was quite a strong school of thought which considered phosphorus a valuable factor in improving the resistance of cast iron to wear owing to the hardness of the phosphide eutectic.

MR. TWIGGER, without being dogmatic, said he was inclined to think that fairly high phosphorus was beneficial as regards wear resistance. He believed that it might not be altogether a question of the actual phosphorus content but of the nature of the charge and the conditions under which it was melted.

Nickel as an Ameliorative for Draws.

MR. E. J. LEWIS remarked, in regard to exhaust manifolds, that an addition of 1 to $1\frac{1}{2}$ per cent. nickel overcame the tendency for bosses to draw where they joined the pipe section.

MR. TWIGGER replied that there were many instances where porosity tended to occur in the thick portions of castings of differing sections. In replying to Mr. Edwards on the question of shrinkage stresses, he was naturally thinking of the actual stresses in the material. Some forms of porosity were undoubtedly shrinkage cavities; but, on the other hand, thick sections when drilled often showed a porous appearance due to the very open grain. Nickel and chromium certainly tended towards securing a closer and more uniform grain and assisted more regular shrinkage. They were not an infallible cure for porosity, neither were they always necessary. Much could usually be done by careful selection of mixture and close study of methods of running.

Cast-Iron Brake Drums.

MR. W. J. MOLINEUX, speaking of solid cast-iron brake drums, observed that the mileage figures of 40,000 and 80,000 quoted were higher than those of which he had experience. It was no doubt difficult to arrive at comparative figures, as much would depend on the type of vehicle. In the case of larger vehicles subject to heavy service conditions, he thought the shoes had to be adjusted every so many hundred miles when using high-carbon steel drums. With cast-iron drums, the conditions were altogether altered, but it seemed difficult to believe that a mileage of 40,000 could be obtained before adjustment or attention was required. Solid cast-iron drums were in use on various large commercial vehicles, so there seemed little question that they were sufficiently strong.

MR. TWIGGER said his mileage figures were based on actual experience of service. Some cast iron which had been inspected after 40,000 miles showed practically no wear, and the report was made that there was no reason why the life should not exceed 100,000 miles. He was quite aware that there were many large cast-iron drums in use. A big advantage of a composite brake drum using steel pressings or aluminium castings, with a cast-iron liner, was that it could be very considerably lighter than a solid cast-iron drum, and thus ensure a saving in unsprung weight. Regarding Mr. Molineux's remarks respecting the use of chromium and nickel, Mr. Twigger said the object of the nickel was mainly to minimise the chilling effect of the chromium without detracting too much from the advantages of chromium in heat resistance.

MR. MOLINEUX said he rather differed as to the chromium effect; he understood it made the surface liable to crack.

Result of Overloading.

MR. TWIGGER remarked that he had seen two cases of ordinary cast iron in use, one as a complete drum and the other a brake-drum liner, where there was definite surface cracking. In the case of the drum, it had been tested out under brutal conditions. Definite decomposition occurred on the inside of the drum; the pearlite had broken down. Moreover, owing to the high temperature, the surface of the material had actually been made to flow under the heavy brake pressure. The surface cracking was undoubtedly connected with the breakdown of the structure under heat.

HARDENED AND TEMPERED ALLOY CAST IRON.

Another aspect of alloyed cast iron was developed by Mr. J. E. Hurst in his Paper "Further Experiments in Oil Hardening and Air Hardening Cast Iron."

At the conclusion of Mr. Hurst's address, the Chairman (Mr. G. C. Castle) said they were indebted to the lecturer for an excellent Paper. He would like, before the discussion commenced, to say how pleased he was to welcome to the meeting Mr. A. G. Harrison, the President of the Middlesbrough Branch, and also several visitors from the south.

Machining Allowances.

Mr. A. G. Harrison expressed his appreciation of the chairman's welcome, and conveyed the best wishes of the Middlesbrough Branch to the Sheffield Section.

Dealing with points raised in Mr. Hurst's Paper, Mr. Harrison said he concluded that the lecturer's experiments were more or less leading up to the question of wear in such components as cylinder liners and brake drums. He would like to ask Mr. Hurst whether there was increased wear in the case of brake drums as a result of the hardening treatment he had described. Then he would also like to know whether extra machining allowance had to be made on account of the warping of the castings when being treated and which would necessitate a much slower machining afterwards.

Mr. Hurst replied that he thought the general consensus of opinion was tending towards the view that in the aggregate these hardened and tempered materials were definitely giving increased life. They might get individual cases which gave a poorer life, but in the aggregate the life was certainly increased. He did not quite understand Mr. Harrison's reference to increased machining allowance on the drums. What Mr. Harrison had in mind was probably increasing machining allowance to cover effects due to distortion in hardening. Distortion need not always arise in hardening. It depended very much in the first place on the material used, secondly, on the treatment and the way it was carried out, and, thirdly, in the case of brake drums, on the design of the brake drums. It was possible to obtain materials which would harden and temper without extensive distortion, so much so that the ordinary machining allowance could be used.

Microstructures.

Mr. C. Wood said that one item that would be of great interest to him, and no doubt to others, was the question of structures after hardening and tempering. They naturally anticipated a great difference in structure after quenching and from what Mr. Hurst had told them he understood that, after the tempering of the alloy, the structures would be somewhat modified.

Mr. Hurst said that he dealt with the structures to some extent in his previous Paper and gave microphotographs illustrating that Paper and showing the structures that were obtained in these alloys after hardening and tempering. The structures of the alloys behaved in precisely a similar manner as steel and other iron-carbon alloys did when treated in the same way. In the as-cast condition the carbon existed generally in pearlitic form.

Machining and Grinding.

Mr. Dadswell asked for Mr. Hurst's views in regard to the treatment of alloy cast iron and said he presumed that it had to be finally ground after treatment.

Mr. Hurst said that in the untreated condition the alloy cast irons were probably slightly more difficult to machine than ordinary cast irons. At any rate that applied to the composition of the materials described in the experiments. That difficulty, however, was of a very small order and of no commercial moment When the materials were in a hardened and tempered condition the difficulty of machining depended on the Brinell hardness. A Brinell hardness of about 300 was about the limit to which they could machine with anything like commercial speed. Brinell figures higher than that made it impossible to machine for that kind of work. In all cases where the hardened and tempered material was used in the hard condition, above 300 Brinell provision had to be made for finishing by grinding.

Inherent and Induced Hardness.

Mr. A. G. Harrison said he understood that a 5 per cent. nickel cast iron was in a hardened martensitic condition as cast. Was there any similarity between the as-cast condition and the result produced by air-hardening and quenching?

Mr. Hurst said that was quite correct. When the nickel content of cast iron existed somewhere in the neighbourhood of 6 per cent. the cast iron was then normally in a hard condition and the structure was similar in character to the structure of those alloys in the quenched condition—that was to say, martensitic. In that condition they would have a Brinell hardness of round about 400 to 500. Naturally they were very difficult to machine. The opinion was held in many quarters that the production of hardened castings by hardening and tempering was better than using martensitic cast iron, because they could have the castings in a soft condition for the machining operations, after which the castings were hardened prior to final grinding. By that means the difficulties associated with machining 5 per cent. nickel right from the casting through to the finished article were avoided.

Limit of Chromium Content.

Mr. T. R. Walker said he noticed that the first alloy used by Mr. Hurst was a plain chromium cast iron and the second a nickel-chromium, and he would like to know if the author had experimented by increasing the amount of chromium addition and replacing thereby the nickel. Nickel was very much more expensive than the high-carbon ferro-chrome or similar alloy used for the making of chromium additions.

Mr. Hurst answered in the affirmative and said that varying percentages of chromium had been tried. There was a limiting value in regard to the chromium content in cast iron. That limit was governed by the liability of these high carbon alloys to exist in the white condition in the presence of chromium.

Mr. Walker asked what that limit was.

Mr. Hurst replied that that depended on several things such as the thickness of the casting and the silicon content. It was not very high but he would not like to give a figure.

Influence of Sulphur.

Mr. C. Wood asked as to the effect of the sulphur on Mr. Hurst's experiments.

Mr. Hurst said he was afraid it sounded bad in a meeting of foundrymen to confess that they almost entirely neglected sulphur, but it was true that they had almost forgotten that sulphur existed. They very rarely estimated it. Within the usual limits of variation in foundry practice it had no effect whatever.

Influence of Manganese.

Mr. G. L. Oxley remarked that Table VIII of the Paper showed that the ordinary cast iron had 0.65 per cent. manganese whereas the others had 1.10 and 1.05. He supposed that the manganese made considerable difference in these tests.

Mr. Hurst said that the difference in manganese would be accompanied by some difference in the results. He believed, however, that the difference would be of a very small order and would not affect the uniformity of the curves shown in the diagrams, Figs. 5 and 6. It might be expected that the lower manganese would be responsible for a lower hardness value after quenching.

Practical Methods Detailed.

Mr. Hearnshaw invited Mr. Hurst to explain the method of oil-hardening and tempering.

Complying with this request Mr. Hurst said he was afraid that in one respect the Paper might be considered to suffer because it gave no details of that sort, but he thought that reference to his previous Paper would give the information as to the methods adopted for oil-hardening and tempering. The method was quite simple. The articles to be hardened in the works with which he was concerned were heated to the hardening temperature in an electric furnace of the resistance type controlled by means of a pyrometer. When the articles had attained the desired temperature they were withdrawn carefully and immersed in whale oil contained in suitable containers of large enough capacity to take a volume of oil sufficient to ensure effective quenching. The articles were allowed to cool off in the whale oil. Then they were withdrawn. The tempering in the works with which he was associated was conducted in a bath of molten salts. Those salts were commonly used in hardening processes and consisted of various chlorides and nitrates mixed together. They had melting points of various ranges, from 200 to 500 and from 400 to 600 deg. C. The bath of molten salts in his case was gas fired and when the molten salts reached the required tempering temperature, the articles to be tempered were immersed in the molten salts. In the case of cylinder liners they were allowed to stand at the particular temperature desired from 10 to 20 minutes, after which they were withdrawn from the molten salts, washed in boiling water to remove any adhering salt and dried and returned to the machine shop for finished grinding where required. He thought that that described in full detail the process of oil-hardening and tempering. In the case of air-hardening the only difference was that the quenching-in-oil stage was eliminated. The compositions were such that when the articles were allowed to cool down from the particular temperature chosen—cooled down in still air, that is in the open air but free from draughts—the process in itself was sufficient to raise the hardness of the material. The tempering of air-hardened materials was conducted in exactly the same manner as oil-hardened materials, that is by the utilisation of a bath of molten salts. There were other ways, of course, but that was a common and a simple way of conducting the treatment.

High Manganese Essential.

Mr. J. Roxburgh referred to Table X relating to the properties of heat-treated cast irons, and remarked upon the fact that in the first case quoted there was 2.26 per cent. Mn as well as Cr and Ni. In the second example nickel and chromium were absent, but there was virtually the same percentage of manganese, so that really the effect of chromium and nickel was very little so far as the properties were concerned. He would like Mr. Hurst's views on that point. Also he would like to know if the author had experimented with various percentages of manganese above 1 per cent. He had shown a percentage of 2.2 per cent., and he (Mr. Roxburgh) wondered if it was necessary to get as high as that, for, he thought, the manganese would have an embrittling effect. Then, also, in Mr. Hurst's summary he said: "In suitable thin sections plain unalloyed cast iron is capable of being hardened." What exactly did Mr. Hurst mean by "in suitable thin sections"? What was the limit of the section, as Mr. Hurst mentioned a thicker section later on?

Mr. Hurst said the main reason for adding nickel and chromium in all cases, as far as the experiments were concerned, was to increase the hardening effect in the thicker sections. That led to Mr. Roxburgh's third question as to what was the limit of, and what he meant by, "suitable thin sections." He would say that the maximum radial thickness of the sections that came within the category of "suitable thin sections" would be $\frac{1}{4}$ in. Anything above that he would call thick. Mr. Roxburgh raised the point as to whether it was necessary to have such a high proportion of manganese. He would reply that to get the air-hardening effect disclosed in the

Paper it was necessary to have that high manganese. He did not know why Mr. Roxburgh should go so far as to say that 2.2 per cent. of manganese was necessarily accompanied by an embrittling effect. The tests that had been made with material of the sort described so far had not borne out that assumption.

MR. ROXBURGH: Even with a thin section?

MR. HURST: Even with a thin section.

Tempering Temperatures.

MR. T. R. WALKER observed that in Fig. 2 and in Fig. 4, showing the tempering temperatures, the highest temperature was shown in the one case as 400 and in the other 350 deg. C. Did Mr. Hurst consider that the strength after tempering was still going up? He wondered if Mr. Hurst had carried out any experiments with higher temperatures to see if those shown were actually the highest strengths reached, and whether they continued to go up or whether they turned over at the maximum figure shown.

MR. HURST said that really it began to turn over as soon as it passed the Brinell. The experiments in the cases referred to were not carried any further because they reached the Brinell figure they were desirous of obtaining, but they could take it definitely that while those curves appeared to be still going on they would turn over like the others at a later stage.

MR. DADSWELL asked if it was possible to get a thin section with the high Brinell figures one got with liners.

MR. HURST replied in the affirmative. He might be pardoned for saying that the process of utilising liners on such thin sections for both commercial and pleasure vehicle engines was first commercially developed by the Sheepbridge Stokes Centrifugal Castings Company, Limited, using thin section liners in ordinary centrifugal cast iron of the sort that had been mentioned. Laystall's adopted the process at a much later date. The standard thickness of liners adopted by the Sheepbridge Stokes Centrifugal Castings Company for some years had been $\frac{1}{16}$ in. That was the ordinary thickness of cast-iron liners still used in large quantities for lining motor-car and commercial-vehicle engines.

How Alloys are Added.

MR. T. R. WALKER inquired as to the form in which the nickel and the chromium were added.

MR. HURST replied that the chromium was added in the form of chromium bar pig, or sometimes nickel-chromium pig, or by the direct addition of nickel.

MR. WALKER: Would it not be cheaper to add nickel-chromium scrap steel?

MR. HURST: I do not know the price of nickel-chromium scrap steel.

MR. WALKER: £5 a ton.

MR. HURST said he thought the difficulty would be to control the quantity of nickel and chromium required. In making the iron it would be worth while doing it accurately, for accuracy had a great deal to do with the regularity of the results obtained. He would imagine that the use of nickel-chromium steel scrap would be accompanied by some irregularities in the results unless one could be certain of the contents. Furthermore, they might be "done in the eye" by the scrap merchant.

Vote of Thanks.

MR. G. L. OXLEY proposed a vote of thanks to Mr. Hurst.

MR. KING seconded, and said that the Branch was to be heartily congratulated on having a metallurgist of the calibre of Mr. Hurst as a member. A great deal of hard work must have been involved in the preparation of the Paper.

The vote of thanks was carried, and in acknowledgment MR. HURST said that so far as he was concerned he felt that he had inflicted something on the Branch members by giving the Paper. Embodying as it did the results of so much experimental work, the Paper was not an easy one to present, and he presumed it would be better read in quietude by the fireside in THE FOUNDRY TRADE JOURNAL. He was very glad, however, to be allowed the opportunity of giving the Paper before the Branch, and hoped that the results would be of some value, both to the members individually and the foundry trade as a whole. He thought they all knew that if there was anything he could do in any way to assist the foundry trade or the Institute of British Foundrymen he was only too glad to be able to do it. He thanked them for the very patient hearing they had given to his somewhat dry Paper and for the very interesting discussion they had raised upon it.

MR. BELL'S PAPER.

The discussion on Mr. Gerald S. Bell's Paper* to the Manchester Metallurgical Society was opened by MR. E. FLOWER (Vice-President of the Lancashire Branch of the Institute of British Foundrymen), who thanked the council of the Metallurgical Society for their kind invitation to take part in their proceedings. He asked the lecturer how he recommended the nickel addition to be made, as after hearing a former Paper on the advantages of nickel in cast iron one of their local members had tried to introduce 2.5 per cent. of nickel into grey cast iron by dropping shot nickel into the stream of metal at the cupola spout. Evidently something went wrong, for, on analysis, there was absolutely no nickel content found in the iron, whereas all the nickel was found in the skimmings from the top of the ladle.

Piston-Ring Hardness.

MR. A. P. TRAILL (Past-President) thought that engineers everywhere would welcome the advent of a cast iron which gave such increased resistance to wear as the examples quoted by Mr. Bell, and he asked if they could not produce as useful metal with the same iron in casting after casting. He asked Mr. Bell if he would recommend nickel iron for making piston rings, and if so would they be any harder than the liner, or would it be preferable to have the rings as in Diesel engines with softer metal than the liners in order that the wear of the latter should be as small as possible.

"Nomag" and "Nimol."

MR. J. D. HANNAH referred to the similarity of the properties of "Nomag" cast iron to the "Nimol" mentioned by Mr. Bell, especially in regard to the non-magnetic properties due to the constitution being austenitic, and he wondered if any advantage had been taken in the process of break-down of the constitution to form martensite as in the Hadfield steels so that there was thus a great increase in the resistance to wear in the cast iron. He also considered it possible to get such a composition with say 17 or 18 per cent. of nickel that the magnetic transformation point would be lowered to room temperature range, so that merely by placing the hand on such an alloy it would be converted from a magnetic to a non-magnetic metal and revert to its original state with the drop of temperature following removal of the hand. Such metals would have definite applications in some form of scientific instruments.

Alkaline Corrosion Resistance.

MR. E. W. COLBECK took up the attitude that whilst Mr. Bell was probably correct in his views that the presence of nickel conferred no greater resistance to corrosion than did ordinary grey iron in small scale tests, his experience was definitely that such nickel content did give an increased life to large manufactured plant such as 15- to 20-ton vessels having to withstand alkaline corrosive liquids, very probably by the nickel making sounder and cleaner castings. He could confirm from actual analyses made on over a dozen test lugs cast on to one of these large vessels in which it was intended to have 1 per cent. of nickel, and from minimum to maximum he found no more variation in the whole series than 1.03 to 1.09 per cent. which was remarkable. Also within the pearlitic range of cast iron he thought there was a good field for those irons which had to withstand high temperatures, that the combination of nickel and molybdenum would be eventually found more satisfactory than the nickel-chromium combination. In the chemical industries there was an ever-increasing demand for cast-iron vessels to stand up to the combined effects of corrosion and erosion, as in pipes for conveying actively corrosive solutions in which precipitated salts were in suspension. He wondered if this was a promising field for the development of nickel-chromium cast irons with, if need be, anything up to 20 per cent. of nickel and also copper up to about 5 per cent.

Compositional Control.

MR. E. L. RHEAD (Past-President) raised the point that if the silicon in the grey cast iron had to be lowered to accommodate the addition of nickel, since both tended to precipitate graphite, he thought there should also be an adjustment with regard to varying sulphur content in the iron. He did not think it should be ignored, as he considered it would have the tendency to produce an unsatisfactory effect upon the desired pearlitic ground-mass. If the silicon were reduced to the critical percentage it would be found that it might behave towards the precipitation of the carbon in two very different ways with but slight variation in the other conditions, sometimes giving a white iron when it should be grey. Similarly a control should be kept on the silicon when chromium was added, since they acted in opposite directions, and to keep the iron grey the silicon had to be increased with added chromium to get the same pearlitic results and avoid brittleness due to excess of carbide.

Chromium Loss on Remelting.

MR. A. BRIERLEY thought the Paper would appeal more to the metallurgist who had to produce the results than to the foundryman who had to cast the alloy irons. He was interested to learn how Mr. Bell succeeded in getting the requisite amount of chromium into his irons, as he had found considerable loss of chromium when using 60 to 70 per cent. ferro-chrome and making the addition through the cupola in the endeavour to avoid remelting. Reverting to the question of nickel grey iron, he did not see that it should be necessary to incur the greatly increased cost of handling, etc., to effect the remelting, as in the ordinary pearlitic irons it was possible to get quite satisfactory results by taking high-grade pig with a small proportion of scrap heads and runners. On the question of resistance to wear he considered that the conditions of actual service were much too variable to be able to form a reliable standard, whereas by selecting perfectly uniform conditions in a laboratory test with a suitable wear-testing machine, exactly comparable results could be obtained as between one iron and another. There was the possibility of the piston rings being harder in one cylinder than another and thus causing a difference in wear, and also the carbon residue from the oil after combustion could introduce wide differences. He thought the wear of one-thousandth of an inch per thousand miles of ship journey would be considered excessive in most Diesel engines.

High-Temperature Service.

MR. BOOTH wished to know if any variation of the nickel-chromium cast iron which had been able to withstand for a time the temperature of 600 deg. C. could be made to give service at 900 deg. C. as in the case of cracking retorts, where the use of aluminium iron had been advocated. There would also be an outlet for such high temperature resistance iron in enamelling furnaces.

MR. BUTTERWORTH referred to the percentage of total carbon in the grey iron to which nickel

* FOUNDRY TRADE JOURNAL, December 3 and 10, 1931.

was added, and asked what variation in the carbon percentage was permissible in view of the need to lower the silicon as the nickel increased.

Mr. Massey understood that good results had been obtained from 50 per cent. nickel alloy, and asked what advantage this would have over the lower percentages named by Mr. Bell. He also questioned the author of the Paper whether the use of nickel in small percentages would not increase the life of certain mass-production motor-car cylinder blocks in which the wear was generally admitted to be excessive, and the pearlitic type of iron might permit a longer time to elapse before reboring of the cylinders became necessary.

AUTHOR'S REPLY.

Mr. G. S. Bell replied to the various speakers in the discussion, and recapitulated to Mr. Flower the details of the method of adding the nickel up to 1 or 2 per cent. by means of a nickel-silicon alloy which had the advantage of melting more readily in the metal from the cupola spout than the pure shot nickel. In this way if there was a bath of metal in the ladle and the additions were stopped before the final third of the metal was tapped, then he had found no difficulty in getting the whole of the nickel required into the cast iron and practically none was lost in the skum. Replying to Mr. Traill, he quoted results which he had coming to hand from a great variety of sources of Diesel engine liners and other important wearing parts, in which there was a very definite improvement in the resistance to wear shown by the nickel cast-iron liners working alongside those which contained no nickel. He believed that it was preferable to have the liners harder than the piston rings so as to save wear in the liner. He had not any experience of the triple alloy named by Mr. Hannah as showing the remarkably low transformation point, but he considered it could be used to a limited extent. To Mr. Colbeck's contribution he could only affirm that he had found no improvement in the corrosion resistance with small amounts of added nickel in the cast iron, especially towards sea-water conditions; but he certainly saw the possibility of the large scale test with alkaline corrosive liquids reversing the laboratory findings as given by him in the Paper. He further agreed that the increased soundness and uniformity achieved by the nickel addition would also tend to resist corrosion in works plant. He was interested to learn of the value of molybdenum along with nickel in cast iron, and considered that it would be most difficult to arrive at the composition of an iron which should be highly resistant to erosion, once corrosion had started. To Mr. Rhead he reiterated his caution in regard to the necessity for reducing the silicon by reducing it in definite proportions as the nickel was increased, but with the sulphur present in the normal percentage in grey iron he did not think it needed to be considered as altering the constitution. To Mr. Brierley he said that the best method of adding the chromium was not to the cupola charge, but in the form of small-sized pieces of rich ferro-chromium to the stream of molten metal, making only a small allowance for loss into the slag. In his experience it had been amply demonstrated that remelting the nickel iron was a necessity for the strict uniformity which was demanded for the best results, and the cost need not exceed four shillings per cwt. in addition to the primary cost of the nickel, and the results justified it. Although laboratory tests were useful within certain limits, he did not think they had yet successfully reproduced service conditions under which he believed the problem of wear was best studied, even if it did take longer. He could not promise Mr. Booth that the low nickel cast iron would give good service at 900 deg. C., as its limit for any reasonable life was 650 deg. C., but some of the higher nickel content irons, containing also chromium and copper, had been able to withstand prolonged periods at 850 deg. C. without much trouble. He answered Mr. Butterworth that he preferred to keep the total carbon as low as possible consistent with maintaining the machining not too difficult. With under 2 per cent. silicon, he did not like the carbon content to be much above 3 per cent. He had not tried Mr. Massey's 50 per cent. alloy, which was hardly in the cast-iron range, but he understood the cylinder blocks of motor cars showed an increased life when the suitable small quantity of nickel had been alloyed in the iron.

Pulverised Fuel-Fired Rotary Furnace Product.

A recent meeting of the Birmingham, Coventry and West Midlands Branch was held at the King's Head Hotel, Coventry. The Branch-President (Mr. F. J. Hemming) was in the chair, and over 50 members and visitors were present. A lecture was given by Dr. P. M. Macnair on "The Production of High-Quality Cast Iron in Rotary Furnaces." This was published in our issue of December 17. A feature of the lecture was the exhibition of a cinema film showing the charging, melting and general operation of a rotary furnace producing high-quality cast iron. The chairman, calling on Mr. A. Harley (President of the Institute) to propose a vote of thanks, said what a pleasure it was to have the President at the meeting.

Mr. Harley, in proposing a vote of thanks to the lecturer, pointed out that the cupola was still the most useful of melting furnaces in the ironfoundry, although he was very interested indeed to hear the possibilities of the rotary furnace as outlined by the lecturer. He would like to ask for further information regarding the use of different mixtures, the time taken for melting, the use of oil fuel and the cost of grinding coal. What was the amount of iron oxide in the slag from a rotary furnace? He took it that the combined carbon content of the metal could be controlled, but what was important for the automobile industry, could improved impact resistance and wear resistance be obtained from metal melted in this way? Foundrymen and engineers in Coventry were especially keen on high-quality cast irons. He congratulated the lecturer on the lucid manner in which the details had been presented.

Mr. F. J. Cook (Past-President) seconded the vote of thanks, and also referred to the excellent presentation of the subject matter of the lecture.

Oil and Powdered Fuel Compared.

Dr. Macnair, in replying to the vote of thanks, emphasised the advantage of the furnace for producing high-quality metal of all types. Different analyses could be obtained by tapping out a portion of the charge, to give the lowest silicon metal required, for instance, and then adding ferro-silicon or other alloys or carbon for other mixtures. Silicon could be reduced in the furnace by using an oxidising flame with a limey slag. The grinding costs were included in the power figures given in the Paper. Oil fuel was dearer than powdered coal. Coal gives a luminous flame with a high radiation, while oil gives a colourless flame with a low radiation value.

Carbon Pick-up.

Mr. F. J. Cook stated that, with a carefully-controlled cupola, it was possible to obtain iron-oxide contents of 5 to 7 per cent. in the slag, while with a balanced-blast cupola a content as low as 3 per cent. had been obtained. He asked if any difficulties were encountered with carbon pick-up in the rotary furnace. Had the fineness of the coal any influence on the pick-up, and, if so, was trouble experienced as the efficiency of the grinding plant fell off, due to wear?

In reply to Mr. Cook, the Lecturer stated that there was no carbon pick-up, but rather a carbon loss. Carbon could be added in the form of petroleum coke, anthracite, etc. The wear of the impellers in the grinding plant was allowed for in his table of costs, and was approximately 6d. per ton of metal.

Mr. E. J. Lewis asked if the furnace could be used for continuous tapping in a light-castings foundry. The Lecturer replied that for such conditions a single rotary furnace was impracticable, but it was possible to use two small furnaces and get good results.

Melting Losses are Low.

Mr. J. Bell stated that he absolutely agreed with Dr. Macnair in the advantages in quality of iron turned out from rotary furnaces in comparison with that from shaft furnaces. One had the advantage of low carbon content, fine graphite and physical tests hitherto unobtainable.

Furthermore, it must be realised that the melting conditions in such a furnace were under more complete control, and the danger of excess oxidation often experienced in the cupola furnace was absolutely countered by the facility one had in this type of furnace of getting the correct balance between fuel and air. From his experience of a high tonnage of iron turned out from a furnace of the Sesci type, the metal melting loss was less than 1 per cent. in comparison with approximately 6 per cent. from a cupola, and often the slag contained less than 2 per cent. FeO.

Superheating Conditions.

Dr Macnair had ably illustrated the advantages that could be obtained in a rotary furnace by superheating the iron, and the advantages of preheating the air to give the greatest furnace efficiency. Did the lecturer not, therefore, consider that a furnace such as the Sesci type, which preheated all the air to 500 deg. C., would be superior to the furnace illustrated that preheated only part of the air to 300 deg. C.? Surely such a furnace would give higher temperature and quicker melting time—the two major points in determining the value of a furnace. In a furnace such as he mentioned of the Sesci type, charges of 100 per cent. steel could be easily melted, and a 0.3 per cent. carbon steel had been produced at a good temperature. The furnace gave high temperature and quick melting time. He was rather sorry that the time was limited in discussing the Paper, as it lent itself to a good discussion, but he wished to congratulate the lecturer on a very interesting Paper.

In reply, Dr. Macnair stated that he was pleased that Mr. Bell's experience corroborated his own. Undoubtedly there were definite improvements in the quality of iron turned out from furnaces of this type.

Regarding the question of preheating air, there was no reason why the secondary air in a Brackelsberg furnace which approximated to 70 per cent. could not be preheated to 600 deg. C. Furthermore, the isolation of the coal from the preheated air until approaching combustion overcame the possibility of spontaneous combustion.

Major John Colville, M.P., Secretary of the Department of Overseas Trade, was the principal guest at a luncheon meeting of the Sheffield Chamber of Commerce on December 17. In an address he remarked that in the financial year ending March, 1930, the nation spent £220 million on the social services, and £400,000 (or 1/500th part) on the Department which looked after the nation's export trade. While in no way minimising the value of social services, it was necessary to remember that there could be no social services at all, unless industry and trade prospered.

The Casting of Pistons for Internal Combustion Engines.

By R. Fischer.

(*Translated from "Die Giesserei."*)

One of the most important parts of a motor is without doubt its piston. In the first place a low weight is required. Further it must have good running qualities, a heat-expansion as low as possible, a good thermal conductivity, and lastly a high resistance to all possible stresses, especially to wear. This shows that the material must be of high quality. Originally pistons were

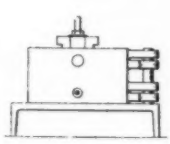

FIG. 1.

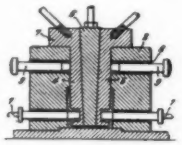

FIG. 2.

made of grey iron. The grey iron piston had, if its structure were sufficient pearlitic, a considerable resistance to wear and a low thermal expansion. But its weight was rather high in spite of thin wall-thickness, and its heat conductivity was insufficient. In recent years the grey iron piston has been completely abandoned, because other materials were produced, which responded to standard demands. Aluminium and its alloys have been developed to an unprecedented perfection, whilst pure aluminium

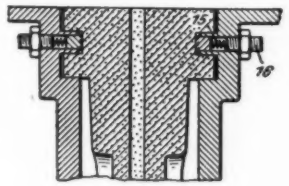

FIG. 3.

has a low specific gravity; but, on the other hand, the other properties required for a piston are rather poor. Such a piston does not have the required resistance to wear nor a sufficient hardness at elevated temperatures, and with high velocities such a high thermal expansion that it is stopped by friction in the case where it fits too closely in the cylinder in the cold state. The aluminium-copper alloys are quite

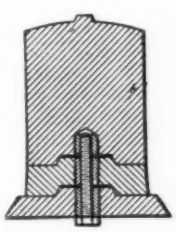

FIG. 4.

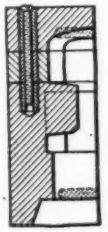

FIG. 5.

different. They can be brought to a sufficient Brinell hardness by heat-treatment, but the thermal expansion is still too high. In order to balance this, special methods are employed as described below.

A good cure for this is an aluminium-silicon alloy, having, apart from good casting properties, a sufficiently good resistance to wear and a low thermal expansion with low specific gravity. The well-known "Electron" alloy is especially light; its specific gravity is only 1.8. If, in the first place, a low gravity is required, the piston can be made of Electron. However, the hardness at elevated temperatures of these pistons is so slight that they are less safe in operation under overloaded conditions than the pure aluminium-copper alloy or grey iron pistons. The ideal condition therefore has not yet been reached, since none of the hitherto known materials responds to all conditions. This article will not describe the characteristics of alloys and their application for the production of pistons for internal combustion engines, but will only give a review of latest notions, used in their manufacture, as these are of vital importance for the quality and usefulness of the finished piston, and since it is mostly produced by the die-casting process, the mould, the core and the method of casting are responsible for the quality of the piston. Since the liquid metal is pressed into the form, only non-ferrous metals are concerned. The mould or chill itself does not present any special peculiarity, but the

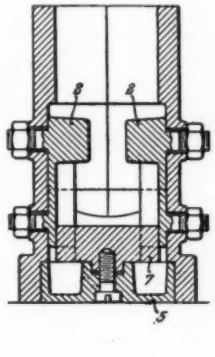

FIG. 6.

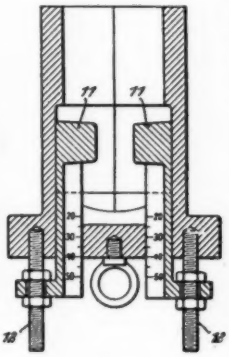

FIG. 7.

core requires greater attention and consideration in order that it can follow the shrinkage of the metal and can also be easily removed.

The mould and core are shown in Figs. 1 and 2. The lower insets (1) are the cores for the pin eyes, while the two upper insets (8) are simple knocking-out pins, which after removing the middle core (6) allow a loosening of the parts (4, 5) of the core from the casting and of the mould (2), after the metal has been cooled. In many cases the core is made of core sand in order not only to allow a shrinkage of the casting, but also to prevent too strong a chill of the inner surface of the piston and of the pin eyes. The feeding is done in this case through a sufficient large gate from above or also from below.

The Americans employ composite cores, being composed of metal and core sand. A little difficulty is experienced in the exact centring of the cores in the chill, especially if they are made of core sand, as they have to be suspended from above. Of interest is a patent which refers to to the centring of a core made of core sand. As shown in Fig. 3, the core is suspended by adjustable screws (16) by means of springs (15). They also allow the adjustment of the core in case the chill expands through heat. In order to eliminate the costly and lengthy manufacture of standard cores for all the many sizes of pistons as much as possible, M. G. Morin has proposed the construction of adjustable cores. They consist, as shown in Figs. 4 and 5, of separate discs, being intended not for different diameters of the piston, but for different lengths.

The same purpose is the basis of a Patent of the Novawerke, Zürich. According to this Patent (Figs. 6 and 7) interchangeable pieces (2) for producing the bosses and an interchangeable bottom (5) and cover (7) are provided. The bottom is adjustable in regard to the bosses. Moreover, the bosses (11) are adjustable by screws (12). Figs. 8 and 9 show a method to expel the air, which is injurious to the aluminium alloy, before feeding the metal. Thus Fig. 8 shows that a small dish (13) is suspended into the hollow core, which is connected with the chill by the channel (12). The

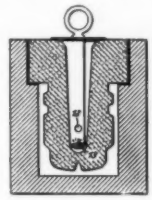

FIG. 8.

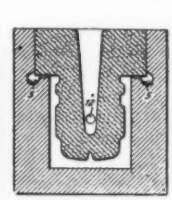

FIG. 9.

dish contains a small quantity of sulphur, which consumes the oxygen of the air by combustion, so that the resulting sulphur-dioxide enters the mould and escapes through the vent holes. Fig. 10 shows a similar method. Here circular channels (5) are provided in the chill, also filled with sulphur. The harmless gases leave the mould through the channel (12) and through the hollow core.

Fig. 10 shows a chill, in which an aluminium

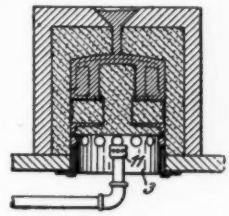

FIG. 10.

alloy piston is connected with a ring of iron or steel (3). This is introduced into the chill and the cast piston is welded to it. The holes in the ring provide a safe connection with the incoming metal. Directly after casting the ring is cooled by a water spray in order to ensure that the aluminium cools rapidly. Finally a method is shown in Fig. 11 for the rapid cooling of the whole casting. The chill is provided with thin ribs (a) which are cooled by compressed air.

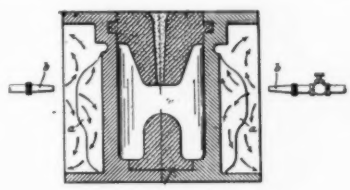

FIG. 11.

A chamber with openings around the chill provides a uniform supply of cold air to all ribs of the chill.

MESSRS. HARLAND & WOLFF, LIMITED, have launched this year 70,298 tons of shipping from their Belfast, Govan and London yards. Of the total, 46,134 tons (including the "Georgic" of 28,000 tons) was launched at Belfast, and 21,212 tons at Govan. The horse-power of the engines installed was 45,600.

Institute of British Foundrymen.

THE SCOTTISH BRANCH ANNUAL DINNER.

The annual dinner of the Scottish Branch of the Institute of British Foundrymen was held in the Grosvenor Restaurant, Glasgow, on December 12. Mr. N. McManus, M.B.E., President of the Branch, presided, and was supported by Bailie Alexander Swan, representing the Lord Provost of Glasgow; Councillor Rev. Robert Daly, M.A., of the Glasgow Education Committee; Prof. J. H. Andrew; Mr. Henry Gardner, M.I.Mech.E.; Prof. A. L. Mellanby; Mr. Archd. Gilchrist, O.B.E., President of the Institution of Engineers and Shipbuilders; Mr. A. Harley, President of the Institute of British Foundrymen; Mr. T. Makemson, Secretary, and the Presidents of kindred technical institutions.

City of Glasgow.

After the Loyal Toasts had been honoured,

Mr. T. Makemson, Secretary of the Institute, in proposing "The City and Corporation of Glasgow," said that the toast which he had to offer was one of great importance. One thought of Glasgow as a great centre of commerce and shipping and all that pertained to it, and with admiration for the manner in which the trade and municipality of Glasgow was administered. At the moment the city was suffering from a great depression, and all over the country sympathy was being expressed for the great blow which had fallen upon the West of Scotland. Although one associated Glasgow with trade, there was another side to it, in which it had played a very big part, and that was in an historical rôle. Glasgow had added to human knowledge and progress of mankind by its inventions and discoveries. Watt—although he was a Greenock man—had the idea which had meant so much to civilisation on Glasgow Green, and it was on the Clyde that the first trial of his engine took place. In the educational world, Glasgow held a leading place, as it was the first city to have a technical college, and it might be said that technical education really began in Glasgow. The present Royal Technical College was famed throughout the world, and the Institute was proud to be so intimately associated with that college. They held their meetings there, the Scottish Branch was born there, and they were delighted to have as one of their members Prof. Andrew, and were gratified at his interest in their Institute. Glasgow could not have progressed in the way it had without the good guidance of its Corporation. The Institute appreciated the help which the Corporation had given, particularly in respect to the educational activities, and that appreciative gesture extended to the Scottish Branch in April, when they considered the celebration of a 21st birthday sufficient cause to be recognised. It indicated the great value which Glasgow put upon the work which the Institute was doing.

Attracting New Industries.

Bailie Alexander B. Swan, in replying, said that he had first to apologise for the absence of the Lord Provost, who found that other duties would not permit him to attend, but he had asked him to act for him. Like many other cities, Glasgow had formed a development council for the purpose of attracting new industries as well as reviving old ones in the city and district. As one associated with both the Glasgow and also the National Development Council, he did not think that there was a finer district or area in the West of Scotland for the development of industry than in and around Glasgow. He had recently discussed the question with a prominent trade union official, who agreed that his view was correct. The question of rates was often made a prominent factor, but he considered that rates meant nothing much to industry, since they had the advantage of the de-rating scheme to the extent of 75 per cent. They should think rather of the benefits which Glasgow gave. No other city gave the plentiful and cheap water supply that Glasgow gave, and certainly no other city gave 22 miles for 2d. on the trams.

Toast of the Institute.

Mr. Henry Gardner (Glenfield & Kennedy, Limited), in proposing the toast of the "Institute of British Foundrymen" said it gave him great pleasure to offer this toast for their acceptance and at the same time felt that he had been greatly honoured in being entrusted with the task. He did not propose to detain them for long, in fact his speech would resemble a requiem in a few words. The Institute of British Foundrymen was founded in 1904 so that it was now 27 years old, but they would fully realise that it was not the life of such an Institution which counted but what was achieved during the lifetime.

The Institute had so far achieved much and its efforts had resulted in an unbroken series of successes going to prove that it was being guided by wise officers and benefiting the trade to the fullest extent. He liked the title of the Institute of British Foundrymen—it was inspiring and something to be proud of. The nation whose name it bore was, unfortunately, passing through hard times, and it might be that in their more pessimistic moments they felt downhearted, but he asked them to remember that Britain had gone through dark and hard times before and they must hope for the return of brighter times in the near future. The Institute played no unimportant part in the success of the country in increasing the productivity of industry. He had to couple with the toast the name of Mr. Harley whom he had met for the first time that day, but he was sure that the Institute was in good hands and would continue to progress and prosper under the President's guidance.

Recent Outstanding Progress.

Mr. A. Harley, in replying, said he had been pleased to have attended the council meeting earlier in the day and to have learned of the progress which the Branch was making. There were some facts which perhaps were not known to all of those present. The membership was now 272, so that the Branch was nearly the biggest, or at any rate the second largest, Branch. The Scottish Branch had shown much initiative and enterprise. He was pleased to know of the activities in the East of Scotland and recent meetings in Edinburgh with the probability of establishing a section in that city. That would mean more members, which in turn meant the opportunity of doing more good work. He would like to refer to their first President, Bailie King, who had recently passed away, and who did so much to lay that sure foundation upon which the Scottish Branch had been built. The Branch had done its fair share towards the work of the Institute as a whole. Three of its members had become Presidents and three had been awarded the gold medal of the Institute.

The Scottish Branch had been very fortunate in its officers and Past-Presidents, and particularly at present, when, as is generally known, they have the best secretary. The Institute itself has now 1,936 members, and there has been an increase of over 100 during the past year. It is more active during these dark times than ever before. The difficulties of things show what men are, if they showed plenty of grit they would continue to go on improving. There were 114 Branch meetings held during the year, and he maintained that the life of the Institute was in the Branches, and a great deal of the work was done by the Branches. That work was all voluntary; the best work was always done by volunteers because of their enthusiasm. A review of the work of the Institute during the past five years will show that they were doing everything possible for the production and improvement of castings for the trades, especially the great engineering trade. He believed that the employees in the engineering and foundry industries were as alive as employees in any other.

He had referred to the Scottish Branch enterprise in Edinburgh, but there were two other Sections started during the year, namely, at Lincoln and Preston, so that the Institute was growing not only in numbers but in usefulness. He was anxious to mention the Technical Committee because he was particularly desirous that it should go on on proper lines. He wanted the Technical Committee to be the means of bringing the latest results to the foundry floor, and then they would have the support of the members. The educational side of the Institute's work was going well, and he was particularly pleased to learn that the Scottish Branch had been asked by the Corporation of Glasgow to appoint an advisory committee to assist in the arrangements for classes in foundry work. In regard to the financial position of the Institute, he was a great believer in the balancing of their budget, and it was pleasing to know that for the current year they had a surplus of income over expenditure. It had given him a tremendous amount of pleasure to listen to the Paper given by Mr. Gardner that afternoon on an "Engineer's View of the Foundry." He would ask all engineers to take an active interest in the foundry side of the business, the more they did that the better it would be for both industries.

The Chairman said that before calling upon Prof. Andrew to propose the next toast, he wished, on behalf of the Scottish Branch, to convey to him their congratulations upon his appointment to the Chair of Metallurgy at the University of Sheffield and to wish him every success in his new sphere.

Value of Technical Institutes.

Prof. J. H. Andrew, in proposing the toast of "Technical and Educational Institutions," said there were a great many people who thought that there were too many societies, and suggested that there should be an amalgamation of those with more or less similar objects. He did not agree with that view; he thought that, although many of the societies were small, they were bands of enthusiasts, and they should leave them alone and admire their courage. The attendance of men at meetings of the societies had the result that prejudices were broken down, because when men came together and one read a Paper and the others discussed it, knowledge was exchanged and circulated. If one told another about a particular process, it did not mean that the other carried away all the details of the process, because, obviously, it was only the firm who were successfully working the process was expert in all the details of it. Then there were the social contacts made by attending the meetings and mixing with those engaged in similar pursuits which were so valuable. He observed that the President of the Institution of Engineers and Shipbuilders was present, and he thought that that Institution must be closely allied to the Institute of British Foundrymen, so that the former may help the foundrymen to understand the intricate castings which they design. Then regarding the Corporation, is it not carrying out important research work? It represents a research association of which all the citizens were members. The only complaint against it being that the subscription rate was rather high.

The Ideal Industrialist.

Mr. Archibald Gilchrist, O.B.E., President of the Institution of Engineers and Shipbuilders in Scotland, in replying, said that he considered

it a very high honour to be asked to reply jointly with a member of the Corporation to what appeared to be a very important toast. They were always told that they must not lack courage and must take some risks in industry. He listened recently to a wireless address by a well-known educationist, who took for his text, "How to Live," and he confessed that he was much impressed with what that speaker said, and thought that there was an enormous amount of truth in it. They were inclined to try to do too much, and that was borne out by what Prof. Andrew had said about the great number of society meetings which he required to attend. He thought that, with all the brilliant brains which they had, they asked them to do too much. The classes in the colleges and universities were too big, and they tried to cram the young people with too many subjects. The greater number could not possibly absorb all that was tried to teach them. He was afraid that the tendency was to breed a race of specialists. Specialists were no doubt very important men, but the country could not carry 100 per cent. specialists. They had got to fight for supremacy and knowledge of the whole business, and it was necessary to have a general knowledge of all cognate factors. There were no mysteries of science, and there was no use in locking knowledge in safes. He advocated the free visit to works and facilities for seeing all that was going on. If one might be bold enough to give what Britain required for recovery to-day, he would give his specification for a successful leader of industry as one having 25 per cent. practical training, 25 per cent. theoretical training, 25 per cent. commercial knowledge, and 25 per cent. common sense, and preferably with a few more per cents. on the last item. Specialists may be necessary, but they must be made up of all those components. If we can make leaders of that type, recovery of our industries will not be long delayed.

Technical Educational Movements.

COUNCILLOR THE REV. ROBERT DALY, member of the Glasgow Education Committee, who also replied, said that, like Bailie Swan, he was only a substitute and had to apologise for the absence of Mr. Malcolm McCrae, the convener of the Education Committee, who found it impossible to be present. There had always been a very close connection between the Scottish Branch of the Institute, and the Glasgow Corporation and he hoped that it might long continue. The foundry classes this year were smaller than usual, being about 50 students less than last year. He did not quite understand the reason for the reduction in the numbers attending, but it had probably something to do with the present trade depression, but personally he thought that trade depression was perhaps blamed more than it should be. He appealed to the members of the Institute to do everything possible to bring the classes to the notice of the lads entering the foundry trade. He was not unmindful of the interest which the Institute did take in the education of the lads and the classes which the Corporation had been able to arrange for them. He did not forget the excellent gift of £100, the income from which was to be used to found prizes for the students in the foundry classes. The Education Committee valued that gift very highly and also the fact that it was associated with the name of one with such a close relation with the Institute, the industry and the city. He thought another reason for the small number of enrolments in the classes was that many of the lads did not find the theoretical subjects so interesting as the practical. Lads want to work with tools and concrete things: they wanted a bigger mixture of theory and practice. At the present time it was hardly possible to persuade the Corporation to sanction the heavy expenditure required to provide the large equipment really necessary for carrying out the more practical instruction. They had already made much progress and were anxious to co-operate with the Institute and trade if they in turn would co-operate with the committee. The Institute had asked for the setting up of special classes for lads who wished to qualify for the City and Guilds of London certificate, and the committee readily responded to that request. There were at present 16 students enrolled in the pattern-making practice classes studying for that examination. He hoped that that was but a beginning of bigger things for their particular trade; in any case it indicated that the committee was at least willing to assist them in improving the status of the lads engaged in their industry.

The Scottish Branch.

MR. HARRY GREER, President of the Local Section Institute of Metals, in proposing the toast of the Scottish Branch, said the Scottish Branch was this year particularly fortunate in having Mr. McManus as its President. He knew the thoroughness with which he carried out his daily work and he knew that he would bring that same thoroughness into the work of the Institute. It had been stated by a previous speaker that the Institute was founded in 1904, but he wished to say that they were really the oldest of technical societies and was started in 1551 when the Guild of Hammermen took charge of the interests of their trade and imposed tests of competency. In 1856 the guild became a charitable institution and has remained so ever since. He asked everyone to pledge the toast of themselves and the President.

MR. N. MCMANUS, M.B.E., President of the Branch, in replying, said that it was perhaps fortunate that their anniversary dinner found them still in the midst of a trade depression from which it appeared there was no immediate escape. Yet in spite of it the great Institute to which they belonged held its own, and the Branch to which they were particularly attached more than held its own. One might ask what is the Institute? It was really a group of men connected with the foundry trade who met at least once a month to hear Papers read and to discuss them for the benefit of the foundry industry. The fact that these men gave up their Saturday afternoons and paid a yearly subscription was sufficient evidence of their enthusiasm and of their desire to make themselves more efficient to carry out their duties was not so much appreciated as it should be by the employers, otherwise the membership would be very much greater than it is, although even in this direction there was an appreciable evidence of improvement. He hoped that more employers would take an active interest in the work of the branch and the Institute for the benefit of the industry.

During the evening a musical programme was provided by Messrs. Harry Robertson, William Gibson, Robert Ballantine and the President of the Branch. Mr. Rodney Winterton acted as accompanist. MR. H. D. CAMPBELL, Senior Vice-President, proposed a vote of thanks to the artistes and all who had contributed to the success of the function mentioning, in particular, the secretary, Mr. John Bell. MR. JAMES MILLER, immediate Past-President, proposed a vote of thanks to Mr. McManus for the manner in which he had presided. The meeting then ended with the singing of "Auld Lang Syne."

Grinding coolants can be filtered by tieing a muslin bag over the coolant exit pipe to the tank.

The following companies, all described as textile plant manufacturers, have been registered. In each case the capital is given as £100, and A. Liston, 81-7, Gresham Street, London, E.C., is registered as subscriber:—Asa Lees & Company, Limited; Brooks & Doxey, Limited; Dobson & Barlow, Limited; Howard & Bullough, Limited; John Hetherington & Sons, Limited; Platt Bros. & Company, Limited.

The Italian Congress Reviewed.

An interesting account of his experiences and impressions of the Italian Foundry Congress in Milan last September was given at a meeting of the Middlesbrough Branch of the Institute of British Foundrymen by Mr. T. Makemson (the General Secretary), one of the British delegates. Mr. A. G. Harrison, the Branch-President, occupied the chair.

MR. MAKEMSON, at the outset, said that the Italian Congress was the first that had been held in that country, and naturally the Italians were very anxious to impress the visitors with the industrial development of the country. The organisation was carried out on a really lavish scale, and just under a thousand delegates were present, 200 being foreigners. The main congress was held in Milan, the most important industrial and commercial city in the country, and it lasted about five days. The speaker said he was impressed by the serious intentions of the Italians. Although there was a social side to the Congress, they did not let it encroach upon the business activity.

Unlike most exhibitions of that character in this country, where foundry plant and machinery was to be seen, castings predominated. There were, of course, some stands showing equipment, but among these exhibitions there was nothing that was very novel.

The most interesting of these stands were those showing core-blowing machines. These machines were evidently giving a great deal of satisfaction, and one of those on view was certainly a very impressive machine. There were also several types of conveyors on view, and it would appear, he said, that the manufacturers were endeavouring to introduce these conveyors not only into the big works but into small workshops and the foundry. It was also evident that the electrical furnace had made a big stride in that country. One of the British firms represented at the exhibition was that of Messrs. Harrison Brothers, of Middlesbrough.

Dealing with the castings side of the exhibition, Mr. Makemson said the exhibitions were of a very high order. The Italians appeared to be giving a great deal of attention to alloy steels, and they were producing castings to withstand all kinds of usage. The exhibitions of die-castings were also the most varied that he had ever seen. There were several ornamental-casting stands, and this art seemed to be very highly developed in that country. There was a very definite demand for ornamental castings, and the Italian was answering this demand in the very best way.

The historical section, he thought, was not a success, but the educational side was very good. Mr. Makemson said that the Italians seemed to be developing the trade school more than we in this country were doing. The work from these trade schools on view was very good. The Constantine College of Middlesbrough also had a good stand in this section.

From the visitors' point of view the equipment stands were disappointing. One notable feature was the great attention the Italians pay to moulding sand. Every effort is made to conserve their supplies, and in the foundry the sand is subject to careful treatment.

Describing some of the works visited during the tour, Mr. Makemson said that a most interesting time was spent at the well-known Vanzetti steel foundry, and here they saw castings being made ranging from 3 to 4 tons to such small articles as inkstands and ashtrays.

The Polytechnic College at Milan was next described, as well as the magnetite mine at Cogne. Speaking of the Fiat cylinder foundry, which the visitors inspected, Mr. Makemson said that here the conveyor principle was really effective. The Congress was brought to a close by an inspiring meeting held at Rome.

The speaker was accorded a hearty vote of thanks at the close.

Heat-Resisting Alloys.*

By J. Ferdinand Kayser.

Engineers refer to all metals which are required to work at a temperature higher than, say, 200 deg. C., as heat-resisting alloys. In this communication the author intends to deal only with metals suitable for use at 700 deg. and upwards. In general, alloys suitable for use at temperatures above 700 deg. C. are not economical at lower temperatures—in fact, some of them cannot safely be used at lower temperatures, because of the embrittling action of a temperature of 400 to 500 deg. C. upon them.

It is difficult to say whether heat-resisting alloys created the demand or whether the demand created heat-resisting alloys. As far as can be determined, it appears as if the desirable heat-resisting properties of a few alloys first attracted attention, and that led to research which resulted in the present-day range of heat-resisting metals.

Properties of Heat-Resisting Alloys.

The ideal heat-resisting alloy must have a combination of properties. No one alloy possesses all the desirable qualities and it is necessary to compromise and to have available a considerable number of different alloys each characterised by some particular feature without completely sacrificing any feature. The following characteristics are required:—(1) Resistance to oxidation at 700 deg. C. and upwards; (2) resistance to furnace gases containing sulphur compounds; (3) maximum possible strength at and above 700 deg. C. over and above that necessary to support its own weight; (4) capacity of withstanding repeated heating and cooling without permanent change of dimensions or disintegration; (5) no permanent change of dimensions after prolonged heating; and (6) lowest possible coefficient of expansion and highest possible ductility at all temperatures.

Resistance to Oxidation.

Resistance to oxidation appears to be a function of temperature as long as the critical temperature is not exceeded, and if an alloy does not oxidise in approximately 12 to 18 hrs. then for all practical purposes it can be said to be oxidation resisting at that particular temperature. The rate of oxidation above the critical scaling temperature is of no practical interest, because it is always sufficiently great to reduce the working life of the alloys to such an extent that their use is no longer economically justifiable.

It is not proposed to enter into a long consideration of what constitutes oxidation. For the purpose of the present communication it is considered that an alloy resists oxidation if at the particular temperature at which it is tested, the cross-section of unaltered metal is not affected and if corners of machined or ground samples maintain their original sharpness.

The author's tests are carried out in an automatically-controlled electric furnace. The test consists in maintaining for 18 hrs. at 800 deg. C. and then removing from the furnace and examining. Samples showing no signs of scale are returned and maintained at 850 deg. C. for a further 18 hrs. and again examined. The test is continued until ultimately a temperature is found at which scaling has set in and the scaling temperature is then reported as being between that particular temperature and a temperature 50 deg. lower, *i.e.*, an alloy which does not show signs of scaling at 1,200 deg. C. but does show signs of scaling at 1,250 deg. C. is reported as having a scaling temperature lying between 1,200 and 1,250 deg. C.

* Summary of a Paper read before the Newcastle Branch of the Institute of British Foundrymen. Mr. F. Allan (Branch-President) presiding.

Reducing Atmospheres.

An oxidising atmosphere is not, however, the most dangerous. Reducing atmospheres containing sulphur dioxide or sulphuretted hydrogen are the most dangerous atmospheres with which heat-resisting alloys have to contend. It has not yet been established what is the permissible percentage of sulphur dioxide or sulphuretted hydrogen that the different alloys can withstand, but it is known that when the sulphur content of the original fuel exceeds some 1.5 to 2 per cent. the life of alloys containing more than about 25 per cent. nickel is very seriously shortened, whereas nickel-free heat-resisting alloys are completely immune from attack. When nickel alloys have been attacked by sulphur fumes they are always covered with a brittle scale which frequently shows signs of having been molten, although the furnace temperature may never have exceeded 900 deg. C., and on occasion buttons of the scale have been found on furnace floors. The following analysis of such a button is typical:—Fe, 11.2; Ni, 40.5; Cr, 10.4; S, 4.3 per cent.; and C, nil.

Reference to the nickel-sulphur thermal-equilibrium diagram shows that the addition of sulphur to nickel lowers the liquidus and a eutectic composition approximating very closely to Ni_2S, has a melting point of 644 deg. C. If sulphur comes in contact with a nickel alloy, it is quite conceivable that NiS (one of the constituents of the eutectic) will be formed and will ultimately reduce the melting point of the surface to the furnace temperature which may be well below, say, 1,000 deg. C.

Physical Properties at Elevated Temperatures.

There appears to be no relationship between the physical properties of metals at atmospheric temperatures and the corresponding properties at elevated temperatures. At elevated temperatures metals have physical properties similar to those of an exceedingly viscous fluid.

If a tensile test is carried out at high temperatures at the normal rate of loading the majority of heat-resisting alloys appear to have a tensile strength approximating to that possessed by many metals at atmospheric temperature. If, however, the load is applied more slowly the maximum stress falls and it is only possible to obtain a true idea of the strength of any metal at elevated temperatures by stressing it for a long period and observing the strain.

That fact was apparently not appreciated until the publication of Dickinson's Paper to the Iron and Steel Institute in 1922. Since that time a new technique in mechanical testing at high temperatures has been developed, but in spite of the large amount of work that has been done, the real nature of the physical properties of metals at high temperatures are not yet properly understood.

The question the investigator has to answer is a very simple one. It is: "What load can the given alloy sustain at any given elevated temperature over a long period without change of dimensions." The term "long period" may be variously defined as being from one year to, say, fifteen years. If an indefinite supply of apparatus is available and one can afford to wait the result of actually stressing a sample for a period of years, the subject does not present much difficulty and indeed several investigators are proceeding on those lines.

Heat-resisting alloys are, however, already being used regularly and the demand for them is growing, consequently, some method of test is required which will enable one to determine the "safe load-temperature curve" for an alloy within a reasonable length of time, say, two months. Not only is the test-piece liable to change its dimensions due to the strain produced by the load, but also internal metallurgical changes may take place which bring about change of dimensions and whatever test is adopted must also take that into account. Fortunately, chromium-iron and nickel-chromium-iron heat-resisting alloys do not appear to undergo any metallurgical changes which lead to appreciable change of dimensions.

Repeated Heating and Cooling.

Heat-resisting alloys must withstand the effects of repeated heating and cooling. Many alloys are known which possess desirable physical properties at high temperatures, but are so fragile when cold that they cannot be used. The fragility when cold is most probably caused by a normal coefficient of expansion combined with very low ductility. Consequently, any slight unevenness of heating necessarily leads to rupture.

Evolution of Heat-Resisting Alloys.

Present-day heat-resisting alloys appear to have originated from experiments carried out some 25 years ago by A. L. Marsh to produce a wire capable of withstanding the high temperatures developed in electrical heating elements. Nickel soon became brittle, but Marsh found that the addition of chromium produced a very satisfactory metal, and present-day high-grade resistor wire consists of approximately 80 per cent. nickel and 20 per cent. chromium with the minimum possible quantity of impurities. Later it was found that a considerable amount of iron might be introduced without seriously detracting from the heat-resisting properties, and an alloy containing approximately 60 per cent. of nickel, 20 per cent. of chromium and the balance iron was and is still used to a considerable extent. It was from this alloy that the first castings were made.

Marsh always specialised in alloys which could be drawn into wire. Investigation, however, soon showed that alloys capable of being drawn into wire necessarily would not possess any appreciable strength at high temperatures and experiments were directed towards producing metals with maximum possible strength at the highest possible temperature. Unforgeable alloys have in general always considerable greater strength at high temperatures than similar alloys that can be hot forged. Consequently, the most desirable heat-resisting alloys are usually procurable only in the form of castings.

During the last 15 years nickel-chromium-iron alloys have been well developed, and whilst there is still, and probably always will be, a field for low-percentage chromium steels, heat- and acid-resisting alloys of the present consist in general of nickel, chromium and iron. The author is of the opinion, however, that the use of nickel in heat- and acid-resisting alloys will not be extended much further, but that heat- and acid-resisting alloys of the future will be nickel-free iron alloys, containing from 25 per cent. to probably 50 per cent. chromium. One of the chief objections to the use of nickel in any alloy is its high cost. It is impossible to purchase nickel at less than approximately 2s. per lb., whereas chromium introduced as ferro-chromium costing not more than 3d. per lb., is quite suitable for the manufacture of a range of heat- and acid-resisting alloys.

Research during the last five or six years has shown that nickel is not an essential constituent of a satisfactory heat-resisting alloy, but that there are a number of chromium-iron alloys which are in many cases more economical than the nickel-chromium alloys, and that there are also economical alloys containing not more than 10 per cent. nickel together with different percentages of iron and chromium.

Heat-Resisting Cast Iron.

By suitable additions of chromium and carefully controlled casting conditions, or by the

(*Concluded on page* 414.)

A Discussion on Cupola Practice.

Following Mr. H. J. Young's Paper before the East Midlands Branch of the Institute of British Foundrymen, a fairly acrimonious discussion took place centring around material progress.

Quality of Post-War Pig-Irons.

MR. P. A. RUSSELL (Leicester) said Mr. Young had given sound sense, and there was a great deal with which he agreed; particularly the importance of metallurgical control, and the description of graphite. The black flakes shown on the photomicrographs, called graphite, were really voids, partly filled. One interesting point mentioned by Mr. Young was that one could not superheat in the cupola above a certain extent. Mr. Russell would like to have the author's opinion upon the quality of pre-war and post-war pig-irons, as he thought that the post-war irons were not so good as the pre-war.

MR. YOUNG said in his business he had to use any cupola, whether made of an old pipe with tuyeres inset or properly designed, and it was often useless his suggesting that money should be spent on new furnaces. He liked the cupola beyond all furnaces for ordinary work. Concerning pre-war and post-war pig-irons, he did not know. He had used so many different kinds of iron. He always used, as far as possible, irons near to hand in order to save heavy freights, and, given a selection of pig-irons, he could produce any cast iron such as could be made from other English or Scotch pig-irons.

Modern Practice Essential.

MR. R. ORME (Leicester), referring to Mr. Young's statement on the temperature of low-silicon and phosphorus irons, said he could not agree. In a well-regulated cupola and with the coke charges properly controlled, he could get iron as hot, whether it be high- or low-silicon. It was necessary to use more coke on the low-silicon irons. He could not agree with Mr. Young that good materials could be produced from a cupola made up of any old tubing, and said that firms who were using such type of cupola must be in a very poor way to deal with modern requirements. Mr. Young had shown a slide of a rejected Diesel cylinder head, and had referred disparagingly to the use of chills and denseners. If Mr. Young had to control a general foundry, at to-day's prices, he would have to resort to chills to get sound castings.

Chills Sometimes Necessary.

MR. YOUNG replied that if one had a cupola working at its maximum temperature and melting low-silicon irons at 1,450 deg. C., then high-silicon and phosphorus irons would be tapped at less. In fact, what Mr. Orme had said about more coke being used was the same thing put differently. The speaker was taking him wrongly about chills. Chills were *essential* in some classes of work, and some moulders were very clever in their use, but chills should be eliminated as far as possible in the case of the Diesel head shown and suchlike pieces.

High-Phosphorus Iron and Low-Phosphorus Castings.

MR. J. LUCAS (Loughborough) said he had greatly appreciated the Paper. The author had said that he could make any good castings by using poor-quality pig-iron. If the blast-furnace people got hold of that idea the quality of the pig-irons would become worse. The author had referred to people in the South paying heavy freight charges on Scotch irons, when local irons could do the job if there were proper metallurgical control. Mr. Lucas could not agree with this remark. The East Midlands district was in the midst of blast furnaces supplying irons high in phosphorus. He would be very interested if Mr. Young could tell him how to make low-phosphorus castings with those irons.

MR. YOUNG said Mr. Lucas was not entirely fair in asking for low-phosphorus castings from high-phosphorus pigs. In his Paper it said: "Given a selection of pigs."

MR. LUCAS pointed out that in another part of the Paper the author said: "One need not go further than their local irons."

MR. YOUNG said his remark was that one need not go further than "necessary."

Detailed and Qualified Statements as Aid to Progress.

MR. A. E. PEACE (Derby) said Mr. Young should enlarge and qualify his remarks. He (Mr. Peace) would confess he was overwhelmed with the vehemence and the irate way in which the author had attacked the foundryman and the foundryman's metallurgical knowledge. It seemed to him that Mr. Young had taken on the cloak of the prophet John and was crying out in the wilderness. He did not think this wilderness so barren as Mr. Young had alleged. Mr. Young had attacked the pig-iron manufacturers and said no two lots of iron were alike. That led one to think one could not buy pig-irons of consistent quality, but such was not the case. He thought that perhaps some foundrymen did not pay sufficient attention to the blast-furnace data sheets published periodically by THE FOUNDRY TRADE JOURNAL, but if they would they could see where furnaces were being blown out, or relined, and that information would tell them whether they could expect to purchase repeat lots of iron. The author had said his remarks referred to the "average" foundry. He must mean the "below the average" foundries. Perhaps that was the type of foundry with which Mr. Young was in contact.

Mr. Peace then referred to Mr. Young's tests on cylinder liners, and he would agree that they were probably no better to-day than his results in 1923, but he did not think it fair to produce that one example and say there had been no progress since that time. It was not a fair comparison. One might as well take the Pyramids and say there had been no progress in the building trades. Then Mr. Young had brought in the Perlit process, and said that that process had given the greatest impetus to metallurgical science during the past eight years. Mr. Peace did not wish to decry Perlit, but it was not to be assumed because there had been no new patents issued since Perlit there had been no progress. He knew of many materials being produced which were not patented because the Britisher did not bother to take out patents for such things. He, personally, did not pay much attention to patenting every new idea. Would Mr. Young enlarge on the use of ferro-manganese? He (Mr. Peace) could get the same results with ferro-manganese, as if the manganese were there in the charged materials. To sum up his opinion of the Paper, he said it was somewhat stimulating and considerably irritating, and he hoped that the "scratching" caused would do some good.

Qualifications Admitted.

MR. YOUNG, in reply to Mr. Peace, said he welcomed that discussion. It was just what he wanted. He had not coupled the foundrymen with lack of metallurgical application. It was not their job, but the metallurgists'. As to his statement that seldom were two lots of pig alike, he had previously given results of hundreds of tests on pig-irons. They did vary considerably, and he had never seen pig-irons (at ordinary prices) which did not vary. Mr. Peace had said his claims to use any pig-irons had been far-fetched, but during the war amazingly poor irons had to be used, and he still claimed he had never seen a cast iron which could not be produced from a selection of any pig-irons and scrap. *Really speaking, all foundrymen do the same and use all the irons in the country.* Referring to his statement of little progress, he thought his comparison on cylinder liners as good as Mr. Peace's Pyramids.

MR. PEACE: What comparison can we take? Your comparison refers to only one class. One must take into consideration all classes of irons produced to qualify the statement that there has been no progress.

Perlit and Progress.

MR. YOUNG then cited motor-cylinder and locomotive-cylinder work. He knew of cases where there were 50 per cent. more or less faulty pieces, and cases where there was much trouble even when using very expensive materials. He had stated where the progress was not there. Mr. Peace must give evidence to show that the progress was there. As regards Perlit, if one would look back to the time of its introduction in this country it would be found that everyone became educated in pearlitic structure, etc., and the whole country became interested as never before. The Perlit process gave the greatest impetus to metallurgical science of recent years. As to patents, he agreed with Mr. Peace, one could patent even a composition. On the use of ferro-manganese, there had been a mass of work done. He thought if one raised the manganese in cast iron by means of blast-furnace products the results would be different from those got by means of the products of the electric furnace. He used a great deal of ferro-manganese but always with the knowledge that under certain conditions it gave rise to carbon troubles.

Variable Expert Evidence.

MR. E. STEVENSON (Nottingham) said that while Mr. Young was blaming the chemists, he thought the foundryman was very much to blame, because many foundrymen did not take up the advantages offered by science. They looked upon the chemist as a nuisance. Mr. Young had referred to standardisation of irons, what did he mean by a standard iron? Mr. Stevenson referred to chemists being at logger-heads and said his experience was that two experts never agreed. One would say that if one balanced the phosphorus and total carbon, the rest did not matter. Another said, if one balanced the manganese and sulphur, nothing else mattered. Mr. Young had pointed out the folly of using so-called patent medicines, and with that remark he fully agreed. Referring to Mr. Young's statements of using local irons, he was wondering whether Mr. Young could produce good castings from mixed brickyard scrap, without going away to buy expensive pig-irons.

Standard Iron Defined.

MR. YOUNG said he could explain standard irons. Suppose one was using a mixture of 30 per cent. hematite, 20 per cent. phosphoric pig, 40 per cent. scrap and 10 per cent. steel, and containing 1.2 per cent. Si and 1.0 per cent. manganese, that was a standard iron and one had always to put in that composition and that mixture no matter what pig-irons were used. Disagreement between skilled people was essential or progress would cease. As regards using brickyard scrap, one could use it if one had got to and he knew how—but not if it was burned iron or affected by acids, etc.

Cupola Control Limited in Application.

MR. HAMMOND, JUN. (Syston), said he could not agree with Mr. Young's remarks on the lack of progress. As everyone knew, straight irons were still straight irons, and in order to obtain the best results from a certain job it was merely a case of working out the most suitable mixture, so chemists had looked elsewhere for the progress and had achieved success in making castings in alloy irons, and thereby obtained results that could not have been obtained ten years ago with straight irons.

Mr. Young, he said, had attacked the foundrymen on their lack of technical knowledge and

then apologised afterwards. A small foundryman using expensive irons was rather afraid to change, through lack of knowledge, to cheaper irons. It was a lifetime's job to become a qualified foundry foreman, and if one was to dabble in metallurgy it might be a case of a little knowledge being dangerous. Mr. Young had stated that he could obtain irons from the cupola of identical analysis day after day without changing the mixture. He (Mr. Hammond) would like to see the cupola that could produce the same analysis at the beginning and end of a blow, using the same mixture throughout. Mr. Young had replied to Mr. Stevenson that he could use the old brickyard scrap, but even he (Mr. Young) would experience trouble unless he knew the definite analysis of that scrap.

Mr. Young replied that his Paper did not include alloy irons. Progress had been made in that line by the Mond nickel group.

Mr. P. A. Russell said that he did not agree that no improvement had been made in foundry metallurgical technique during the last ten years, but that a general improvement was obvious all round. Instance of this could be seen in the new Admiralty specifications, which were much more stringent than before.

Mr. Young said he supposed Mr. Russell was aware that the new specifications were turned down. The Institute was doing good work. It represented progress. But we were spending large sums of money per year, and what were we getting for it?

Raw Material Purchase.

Mr. Sanders (Derby) said he had heard a very interesting Paper with some very strong assertions. In the main he agreed with the author that expensive irons were not necessary, but if one wanted low-phosphorus iron, then he must buy low-phosphorus pig-iron. The same remarks applied to sulphur. This element was decidedly useful in certain cases. For cylinders and liners it helped to resist wear; for thin, fragile and intricate castings it was a drawback, tending to promote cracking. He congratulated Mr. Young on his excellent tensile tests taken from the Diesel cylinder, and inquired if he was asking too much in requesting for the analysis of that metal.

It had been said that there was no bad pig-iron; if it was unsuitable for one particular purpose it might be quite good enough for another. Our job was to get suitable iron for our own castings; physical tests were not everything; good castings were wanted, for it was the castings which paid the bills.

Mr. Young said that in connection with sulphur, he agreed with Mr. Sanders' remarks. There was no secret in Diesel castings, but one needed the correct mixture as well as the correct composition, to achieve success. As regards his tests, he believed in testing higher than necessary. It was essential to aim at perfection in order to achieve progress, as by so doing one always made progress towards perfection.

The discussion then terminated, and a vote of thanks was accorded to the lecturer by Mr. C. W. Bigg, seconded by Mr. H. Smith.

Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Walker-on-Tyne, have secured contracts for the machinery conversion of five vessels of the Ellerman Line and two vessels of the Anglo-American Oil Company, Limited. Six of the ships are to be converted to use superheated steam and one to the Baeur-Wach system.

The Board of Trade has made the Abnormal Importations (Customs Duties) No. 3 Order, which imposes as from December 19 a duty of 50 per cent. *ad valorem* upon various articles, including fittings and accessories used in interior electric lighting systems; lawn mowers; aluminium sulphate, ammonia alum, soda alum and potash alum; and ammonium chloride.

A New Portable Suspended Electric Vibro Sifter.

A new motorised portable labour-saver has been introduced by Messrs. C. F. R. Giesler, Limited, 324, Gray's Inn Road, London, W.C.1, in the form of a portable suspended electric vibro sifter. This useful machine eliminates a vast amount of onerous manual work, yielding in 1 hr. the same output as two men could accomplish in 5 hrs. by hand labour. The output is increased considerably by arranging several sieves of different mesh one above the other; in this way several sizes of grain can be obtained in one process.

The machine consists of a frame of angle iron A, an electric motor B, a flexible coupling C,

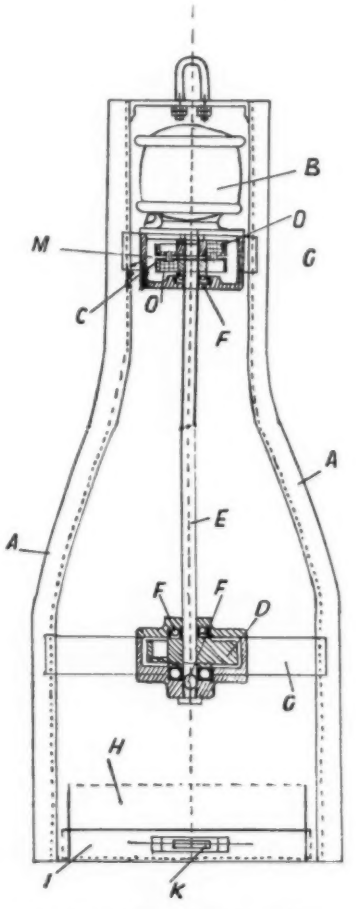

Fig. 1.—Section Through a New Type of Vibro Sifter.

and an eccentric unbalance weight D. The shaft E is supported by ball bearings F, fixed in the transverse G, which serves to reinforce the frame. An iron ring I carries the sieve H. Welded to the ring are threaded nipples K for wing screws, for clamping on the sieve. The coupling C consists of two cast-iron discs P, a leather disc M, four set screws and gripper bolts O, sliding in a groove. When, by means of coupling C, the motor rotates shaft E and the unbalance weight D, the frame oscillates, and this shakes the sieve in a rapid to-and-fro motion, according to the amplitude regulated from the unbalance weight, producing a vigorous screening operation.

The sifter is activated by an electric motor, completely dustproof, of ¼ h.p., fitted with ball bearings, which is connected with the coupling C to keep the apparatus in constant vibration, without producing any rotary movement. In this way the material is evenly spread over the whole sieve, the full superficial area of which is thus utilised. The material to be sifted or mixed is shovelled in and discharged (automatically if required) without the sifting or mixing process suffering any interruption; also the bottom sieve can be exchanged or emptied whilst the motor continues working. The sieve is readily exchanged in a few seconds by loosening a handscrew.

Any hand or special sieve having a fine or coarse mesh, or be round or rectangular, may be inserted. The machine, it is claimed, ill pay for its initial cost within a very short time in the saving of wages and time, whilst the quality of the sifted material shows a great improvement. The electric screen is supplied ready for use and can readily be connected with any electric contact. It is suspended either from a hook or, if required portable, from a running pulley.

Book Review.

Wagon Details and Construction, by P. H. Saunders. Published by Crosby, Lockwood & Son, Stationers' Hall Court, Ludgate Hill, E.C. Price 7s. 6d.

The mere title of this very interesting treatise does not convey an adequate idea as to the amount of information that has been brought together on the subject. The writer has undoubtedly condensed in a simple yet very clear manner the essential points which govern "up-to-date" wagon construction, and whilst giving what in his opinion is the best practice, recognises that no hard-and-fast rule can be adopted, as in the methods of manufacture of certain important details such as draw-bar hooks, axle-guards and brake cross-beams, the manufacturer is very often bound by special conditions of the consulting engineer's specification, and, consequently, the methods actually employed may differ. Special emphasis is very rightly placed on the jigging systems in vogue; these undoubtedly both form the real basis of cheap and rapid production and ensure the interchangeability which is absolutely essential. The illustrations, both as regards the detailed parts and the methods of manufacture, are extremely well selected, and to one desirous of learning the essential points of wagon construction this book can serve as an excellent introduction to the practical side.

T. F. A.

Heat-Resisting Alloys.

(*Concluded from page* 412.)

addition of nickel or silicon to cast iron, it is possible to produce a metal which will not grow, but the temperature at which scaling first appears is not appreciably altered by small additions. If considerable additions of chromium or nickel or any other metal are made, the resulting product cannot be classed as a cast iron because the desired composition can, in the majority of cases, be more economically obtained without using cast iron as a base.

Heat-resisting alloys containing 0.8 to 2 per cent. carbon and chromium between, say, 25 and 35 per cent., are sometimes referred to as high-chromium cast irons. It is possible to make such metals by adding pure chromium to cast irons, but the cost is prohibitive. The most economical method is to dilute ferro-chromium by suitable addition of, say, boiler punchings or similar material.

Statements have been made that the heat-resisting properties of some alloyed cast irons approximate to those of the nickel-chromium heat-resisting alloys. Such a statement cannot refer to physical properties at temperatures of 700 deg. C. and upwards. The writer is of the opinion that metal which may really be called cast iron is not a suitable base for the production of alloys with the six characteristics given in the early part of this communication.

This Week's News in Brief.

Trade Talk.

THE TENDER of Lobnitz & Company, Limited, has been accepted by the Bluff Harbour Board, Wellington, New Zealand, for the building of a new tug. The contract price delivered at Bluff is £35,250.

SIR WILLIAM ARROL & COMPANY, LIMITED, Bridgeton, have received an order for an electric wharf crane for the new dock presently under construction for Messrs. Barclay Curle & Company, Limited.

HARLAND & WOLFF, LIMITED, have received an order to build a cargo steamer for the Bombay Steam Navigation Company, Limited. The vessel will be 230 ft. long and will be built at the Govan yard.

MESSRS. R. & W. HAWTHORN, LESLIE & COMPANY, LIMITED, Newcastle-upon-Tyne, have launched this year five vessels with a total tonnage of 21,031. Three of these were twin-screw motor vessels with a combined horse-power of 9,850.

BIRMINGHAM ELECTRIC FURNACES, LIMITED, have received an order for 37 electric heat-treatment furnaces of various types for export to Russia. This is believed to be the largest single order for electric furnaces ever placed in this country.

A FIRE BROKE OUT in the early morning of December 22 in the foundry of the Grahamston Iron Company, Limited, Falkirk. The roofs and much of the moulding equipment were badly damaged. Arrangements have been made to carry on business as usual.

THE REES ROTURBO MANUFACTURING COMPANY, LIMITED, Wolverhampton, has received from Arcos, Limited, on behalf of the Russian Government, a substantial contract for the supply of machinery, which will keep certain sections of the works busy for about four months.

THE GENERAL ELECTRIC COMPANY, LIMITED, has received an order from the London Midland & Scottish Railway Company for the electrical equipment of the new rolling-stock to be used for the augmentation of services on the Euston-Watford and Broad Street-Richmond electrified lines.

MR. HORE-BELISHA, M.P., Parliamentary Secretary to the Board of Trade, recently completed a week's tour of certain iron and steel districts, made in order to gain information relating to the question of duties on iron and steel. At Scunthorpe Mr. Hore-Belisha visited the Normanby Park Steelworks of Messrs. John Lysaght, Limited, the Frodingham Iron & Steel Works, the Appleby Steelworks, and the Redbourne Iron & Steel Works of Messrs. Richard Thomas & Company. Later he started his investigations in South Wales by visiting the Courtybella Works, Newport, and the Dowlais Works at Cardiff. He then proceeded to inspect the Mansel tinplate works of Messrs. Byass & Company, Limited, the Margam Iron & Steel Works, the Elba Steelworks, Gowerton; the steel, tinplate and sheet works of the Grovesend Steel & Tinplate Company at Gorseinon; the works of the Llanelly Steel Company, Limited, at Llanelly, and the King's Dock Tinplate Works of Messrs. Baldwins, Limited. Finally, Mr. Hore-Belisha attended a dinner of representatives of the steel and tinplate makers at the Hotel Metropole, Swansea.

Contracts Open.

Cairo, January 9.—Two electrically-driven pumping sets for a floating dock, for the Ministry of Public Works. The Department of Overseas Trade. (Reference G.X. 10,989.)

Glasgow, January 16.—Provision and erecting of 75 tons of steel plate girders and cross girders and 2½ tons of cast-iron bed-plates, for the Corporation. Mr. G. Henshilwood, manager, Water Department, 50, John Street, Glasgow, C.1.

Hednesford, January 2.—Supply and laying of 427 yds. of 12 in. dia. and 667 yds. of 9 in. dia. cast-iron sewer, and works, for the Cannock Urban District Council. Mr. R. Blanchard, surveyor, Council House, The Green, Cannock. (Fee £2, returnable.)

Ilkeston, January 11.—370 tons of cast-iron pipes and specials, of 16 in. and 14 in. dia., for the Corporation. The Town Clerk, Ilkeston. (Fee £2, returnable.)

Company Meetings.

Crittall Manufacturing Company, Limited.—SIR VALENTINE CRITTALL, presiding at the annual meeting of this company in London recently, said that despite the large falling-off in building they had succeeded in materially increasing the volume of their home business. This increase had been obtained not so much at the expense of other makers of metal windows as by the conversion to the use of metal windows of an ever-increasing number of those who had previously used wood. In the Darlington Rolling Mills, which was half owned by the company, they were now capable of producing the whole of their requirements, and during the period the capacity to produce light steel sections had been doubled. In addition to material for window trade they were now producing profitably steel for other industries, particularly the motor-car trade. In point of accuracy and rolling quality generally Darlington was now turning out material fully equal to the specialised mills of Germany and the United States.

Crompton Parkinson, Limited.—The annual meeting of Messrs. Crompton Parkinson, Limited, was held in London, on Friday, December 18. MR. FRANK PARKINSON (the chairman), who presided, said that the year had been one of increasing difficulty owing to the decline in purchasing power both at home and abroad, resulting from the international financial situation, and it was a source of gratification that, in spite of the more intense competition which had prevailed, the company had been able to maintain and even increase its share of trade available. These conditions had inclined manufacturers to review the constitution of the industry from a national standpoint and to consider steps by means of which they might co-operate in the national interest. While, however, the board was willing to assist in the consideration of these problems, it could not ignore the special position which the company occupied in the industry, nor did it intend to depart from the policy of economic production which had contributed so largely to the company's success. In pursuit of this policy the directors had examined several fields of possible expansion, but had restricted development to those fields in which they were satisfied that the company's methods of manufacture could with advantage be applied. The new products developed had met with an active demand. During the year they had extended their activities in the direction of the manufacture of plant for railway electrification. Considerable progress had also been made in the design and manufacture of railway electrical equipment, and some important orders were now in course of manufacture at Chelmsford. The directors regarded this development as a very important extension of the company's activities, and one which would increase the company's earning capacity considerably as soon as trading conditions were more normal.

Tube Companies' Merger.

STEWARTS & LLOYDS AND SCOTTISH COMPANY.

The directors of Messrs. Stewarts & Lloyds, Limited, have made an offer to acquire the shares of the Scottish Tube Company, Limited, on the basis of one Stewarts & Lloyds 5 per cent. cumulative preference share for each similar share of the Scottish Tube Company, and five deferred shares of £1 each for each six £1 ordinary shares of the Scottish Tube Company.

The offer is conditional on acceptance by 90 per cent. of each class of Scottish Tube shareholders. If, however, less than 90 per cent., but not less than 75 per cent. of each class accept and special resolutions are passed by the latter percentage putting the Scottish Tube Company into liquidation and providing for the purchase by Stewarts & Lloyds of Scottish Tube assets, then Stewarts & Lloyds will carry through the matter accordingly.

In a circular recommending the offer to their shareholders, the directors of the Scottish Tube Company, Limited, who have for themselves accepted it, state that for some time past they have felt that the time was ripe for a further step in the direction of closer co-operation with competitors, and therefore they welcomed the proposal by Messrs. Stewarts & Lloyds.

Personal.

MR. J. M. ORMSTON has been appointed a special director of Messrs. Vickers-Armstrongs, Limited. He will be in charge of the shipbuilding department at Barrow, directly responsible to Mr. J. Callander.

MR. WILLIAM MCMILLAN has been presented with a Westminster chime timepiece by the staff of Messrs. N. Cockburn & Company, Limited, Gowanbank Foundry, Falkirk. Mr. Leslie Hunter, B.Sc., works manager, presided.

MR. HECTOR C. GRANT, who has been a member of the staff of Lane & Girvan, Limited, Bonnybridge, for many years, has received a presentation from his colleagues on the occasion of his leaving to take up a new appointment in Midlothian.

MR. WILLIAM JAMES RUDD, a charge hand in the ferrous metal department at the works of the Whitecross Company, Limited, at Warrington, has been awarded the Edward Medal in recognition of his gallantry in rescuing two men from a furnace pit which had become filled with scalding steam.

DR. F. S. SINNATT has been appointed by the Lord President of the Council to be Director of Fuel Research under the Department of Scientific and Industrial Research. Dr. Sinnatt has been Assistant Director of Fuel Research since 1924. Previously he was Lecturer on Fuels in the University of Manchester Faculty of Technology, and Director of Research to the Lancashire and Cheshire Coal Research Association.

AN INTERESTING CEREMONY took place in the Burgh Court Room, Falkirk, last week, when James Campbell, Falkirk's first "V.C. of Industry," was publicly presented with the Gallant Conduct Award of the Scottish Safety First Council. The award was made to the boy Campbell in recognition of an act of conspicuous bravery performed by him in the course of his employment with R. & A. Main, Limited, Gothic Iron Works, Falkirk.

Obituary.

MR. JOHN HENRY COGHLAN, formerly managing director of the Coghlan Steel & Iron Company, Limited, Hunslet Forge, Leeds, died recently at his home in Harrogate.

MR. WILLIAM THOMAS HALE, who was well known in the iron and steel trade of the Midlands, died at Paignton recently. He was a director of Messrs. Adams & Benson, Limited, iron and steel merchants, West Bromwich, the Birchley Rolling Mills, Limited, Oldbury, and Messrs. Bradley & Foster, Limited, Darlaston.

Reports and Dividends.

Edward Wood & Company, Limited.—No interim dividend is proposed on the ordinary shares.

Hadfields, Limited.—The directors have decided to defer payment of the preference dividend due on December 31.

Boulton & Paul, Limited.—Loss, £46,696; brought in, £32,390; from reserve, £20,000; available, £5,694; preference dividend, £2,500; no ordinary dividend; carried forward, £3,194.

Atlas Steel Foundry & Engineering Company, Limited.—Profit, £3,205; to debenture sinking fund. £1,500; depreciation, £1,500; dividend of 2½ per cent., £1,406; carried forward, £1,727.

Thos. W. Ward, Limited.—The directors report a slight improvement in trade, but in view of the unsettled conditions which still prevail, they have decided to postpone the payment of the quarterly dividends on the preference shares due on December 31.

Walter Somers, Limited.—Loss for year, after payment of debenture service £11,531 and after charging depreciation £12,229, was £21,280. The amount brought forward £257,751, and preference dividend paid £222, make a total debit balance of £279,252.

Stewarts & Lloyds of South Africa, Limited.—Trading profit, £59,053; from tax reserve, not now required, £3,000; brought in, £3,603; available, £65,656; depreciation, £21,504; written off preliminary expenses, £5,202; preference dividends, £35,500; carried forward, £2,625.

Raw Material Markets.

The close of 1931 has been remarkable for the lack of the usual sentimental heralding of the new year. The iron and steel industries of this country are in an unsatisfactory position and there is little prospect of any immediate improvement.

At present, trade has not fully recovered from the Christmas stoppage, and little new business is passing. The light-castings trade is in the best position; the heavy engineering section unfortunately remains depressed.

Pig-Iron.

MIDDLESBROUGH.—The iron and steel works in this area extended the Christmas holiday to a week or ten days, with a consequent stoppage of deliveries of pig-iron. There will, however, be no noticeable addition to makers' stocks, as production is very limited. Another blast furnace was put out of action last week, to enable repairs to be made, leaving only 17 furnaces in blast on the North-East Coast. Little business is being done in the export market. There is no likelihood of any immediate alteration in prices, which remain as follow:—No. 3 Cleveland G.M.B., 58s. 6d.; No. 1 foundry, 61s.; No. 4 foundry, 57s. 6d.; No. 4 forge iron, 57s. per ton.

The East Coast hematite trade is not in such a satisfactory position, and forward quotations no longer include a premium. The additional furnace that is in preparation will not be put into blast until conditions are more favourable. The hematite trade is also quiet on the West Coast.

LANCASHIRE.—The majority of deliveries against contract have been suspended for the moment, and new business has shown a falling-off, but fair tonnages have already been booked for January and February delivery. The position of the light foundry trades remains good. Prices are unchanged, with Midland foundry makes on offer for delivery to users in the Manchester price zone at 67s. per ton. North-East Coast at 67s., Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish pig-iron at about 87s. and West Coast hematite at about 81s.

MIDLANDS.—The pig-iron trade in this district is quiet, little interest being shown by consumers. There is no sign of any recovery in the heavy engineering industry, but the light-castings trade is fairly well employed. For delivery to Birmingham and Black Country stations, makers continue to quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—The market remains depressed, and prospects for the new year are not hopeful. Only two blast furnaces in Scotland are making foundry iron, with three others on hematite. Scottish No. 3 foundry iron continues at 69s. 6d. f.o.t. furnaces. Cleveland No. 3 is at 61s. 6d. at Grangemouth.

Coke.

The coke market in the Midlands is moving very slowly, but prices remain firm. Best Durham coke is quoted at 37s. 6d. to 39s. delivered Birmingham, while the price of Welsh coke ranges from 30s. to 37s. 6d., according to the grade and the tonnage ordered.

Steel.

The orders received by the finished-steel works are of miscellaneous character and of insufficient volume to ensure steady working. A fair amount of business is being done in the semis market, home works being better occupied. Sellers of Continental material report fair sales despite holiday influences still affecting the market.

Scrap.

The Cleveland scrap iron and steel market has not yet fully recovered from holiday influences, and prices are mostly nominal. Ordinary heavy cast iron is steady at 45s. 6d., with machinery quality at 47s. 6d. The Midlands market remains firm, there being good sales of cast-iron machinery scrap at 52s. 6d. per ton, with 40s. quoted for clean light metal. The South Wales market is quiet, there being ample supplies of scrap available to meet the demand. In Scotland consumers are willing to contract forward at present prices, but merchants consider that the latter are unremunerative. Ordinary heavy cast-iron scrap in pieces not exceeding 1 cwt. is quoted at 47s. 6d. to 48s. 6d. per ton.

Metals.

Copper.—Now that restriction of output has been definitely agreed upon by the producers' conference, interest centres upon the proposed scheme for control of sales, full details of which are not yet published. There have been rumours of an advance in the Exporters' price, but at present the c.i.f. quotation remains at 7.50 cents. The course of the market in Europe has been obscured by holiday influences, but it is evident that the demand for standard is not very brisk.

Closing quotations:—

Cash.—Wednesday, December 23, £38 11s. 3d. to £38 13s. 9d.; Thursday, £39 2s. 6d. to £39 5s.; Monday, £39 3s. 9d. to £39 6s. 3d.; Tuesday, £38 10s. to £38 12s. 6d.; Wednesday, December 30, £38 10s. to £38 11s. 3d.

Three Months. — Wednesday, December 23, £39 5s. to £39 7s. 6d.; Thursday, £39 16s. 3d. to £39 18s. 9d.; Monday, £39 17s. 6d. to £39 18s. 9d.; Tuesday, £39 5s. to £39 7s. 6d.; Wednesday, December 30, £39 3s. 9d. to £39 5s.

Tin.—The announcement by the Pool and the International Committee of further measures to be taken to secure rigid control of the production and sale of this metal has considerably strengthened market feeling; in spite of the fact that the industrial depression in the United States shows no sign of alleviation. There has been some demand from consumers on the Continent lately, good sales having been recorded of Banca and standard.

Official closing prices:—

Cash.—Wednesday, December 23, £141 12s. 6d. to £141 15s.; Thursday, £141 15s. to £142; Monday, £141 15s. to £141 17s. 6d.; Tuesday, £141 2s. 6d. to £141 5s.; Wednesday, December 30, £141 2s. 6d. to £141 5s.

Three Months. — Wednesday, December 23, £144 15s. to £144 17s. 6d.; Thursday, £144 15s. to £145; Monday, £144 17s. 6d. to £145; Tuesday, £144 5s. to £144 7s. 6d.; Wednesday, December 30, £144 7s. 6d. to £144 10s.

Spelter.—The spelter market is steady, and demand on the Continent seems to be absorbing production fairly steadily. Galvanised-sheet makers in this country report no noticeable improvement in conditions. Business has fallen off in the last week or so, owing, of course, to the holidays.

Daily fluctuations:—

Ordinary. — Wednesday, December 23, £14 11s. 3d.; Thursday, £14 11s. 3d.; Monday, £14 6s. 3d.; Tuesday, £14 7s. 6d.; Wednesday, December 30, £14 7s. 6d.

Lead.—There is little to report in this section. Consumers' interest remains small, but production is too strongly controlled to allow of any relapse in the market. Any increase in consumption would result in a speedy improvement.

The week's prices have been:—

Soft Foreign (Prompt).—Wednesday, December 23, £15 5s.; Thursday, £15 5s.; Monday, £15 7s. 6d.; Tuesday, £15 12s. 6d.; Wednesday, December 30, £15 11s. 3d.

Institute of Metals.

AMERICAN MEETING POSTPONED.

In view of the disturbed economic and financial conditions that prevail in Europe and America the Council of the Institute of Metals has found it necessary to postpone the 1932 American meeting, which was to have been held in the United States and Canada next autumn. The meeting had been planned with the close co-operation—as prospective hosts—of the American Institute of Mining and Metallurgical Engineers. The Council's suggestion that the meeting be postponed was sympathetically received in America, and the assurance has been made that the members will be welcome at such later time as may suit their convenience. An announcement regarding the Institute's place of meeting next autumn will shortly be made.

Publication Received.

Pitfalls.—Published monthly by the Institute of Accident Prevention, 62, Grove Avenue, London, W.7. Price 1d.

For a real pennyworth of morbid reading we have seldom encountered the like. The Editor seems to have collected from the scare Press every abnormal fatal accident in recent times and reproduced them in the form of short paragraphs. The *raison d'être* for this new publication is stated in an accompanying leaflet to be that few are satisfied with the present situation. Whilst agreeing that most safety-first propaganda can truthfully be designated in the language of the "bright young things" as pure "tripe," this new effort does not appeal to us as being greatly superior.

Charitable Subscriptions.

Contributions to infirmaries and other charitable institutions have been made by the employees of various Scottish firms, as follow:—Coltness Iron Company, Limited, Newmains, £3,695 18s.; Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbert, £276 2s.; Panther Iron & Steel Company, Limited, Wishaw, £84 13s.; Messrs. Archibald Baird & Sons, Limited, Hamilton, £84; Summerlee Iron Company, Limited, Coatbridge, £1,430 1s.; Bairds & Dalmellington Iron Company, Limited, £700 2s.; Scottish Iron & Steel Company, Limited, £377 14s.; Albion Motors, Limited, Scotstoun, Glasgow, £480; Messrs. W. Martyn & Sons, Limited, Coatbridge, £89; and Shaw Glasgow, Limited, Maryhill, Glasgow, £237 11s.

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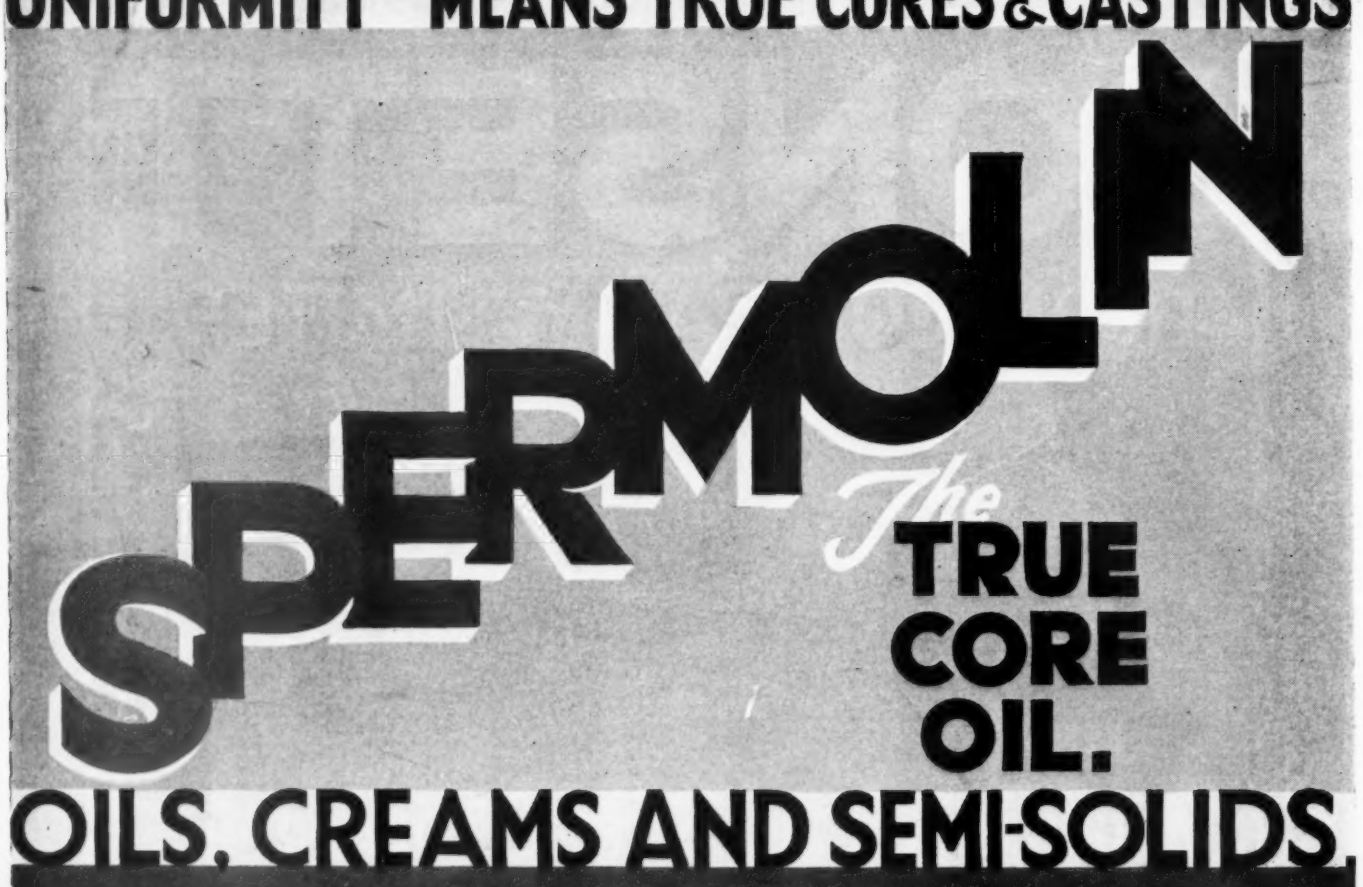

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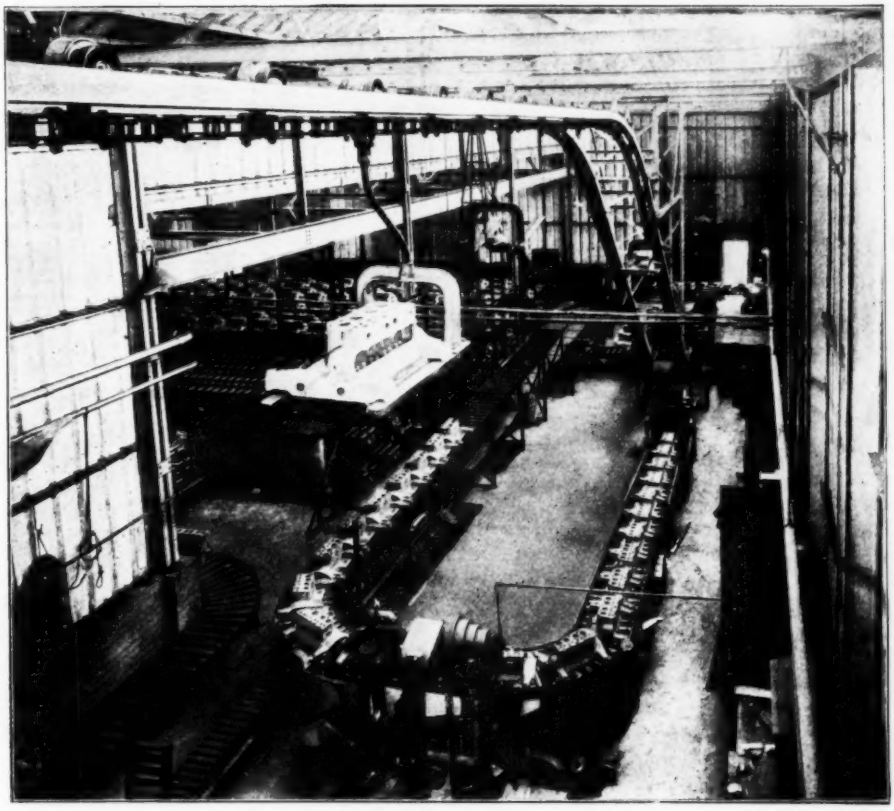

By courtesy of Morris Motors, Ltd.

THE ILLUSTRATION SHOWS A CONVEYING SYSTEM FOR DELIVERING CASTINGS AS RECEIVED FROM THE FOUNDRY, TO THE MACHINE SHOPS. THE STORAGE RACKS ARE SHOWN IN THE BACKGROUND ON THE LEFT DELIVERING TO A "U" SHAPED GRAVITY RUNWAY. FROM THIS THE CYLINDER CASTINGS ARE AUTOMATICALLY PICKED UP AND CARRIED AWAY BY THE OVERHEAD CHAIN CONVEYOR SEEN AT THE TOP OF THE PHOTOGRAPH.

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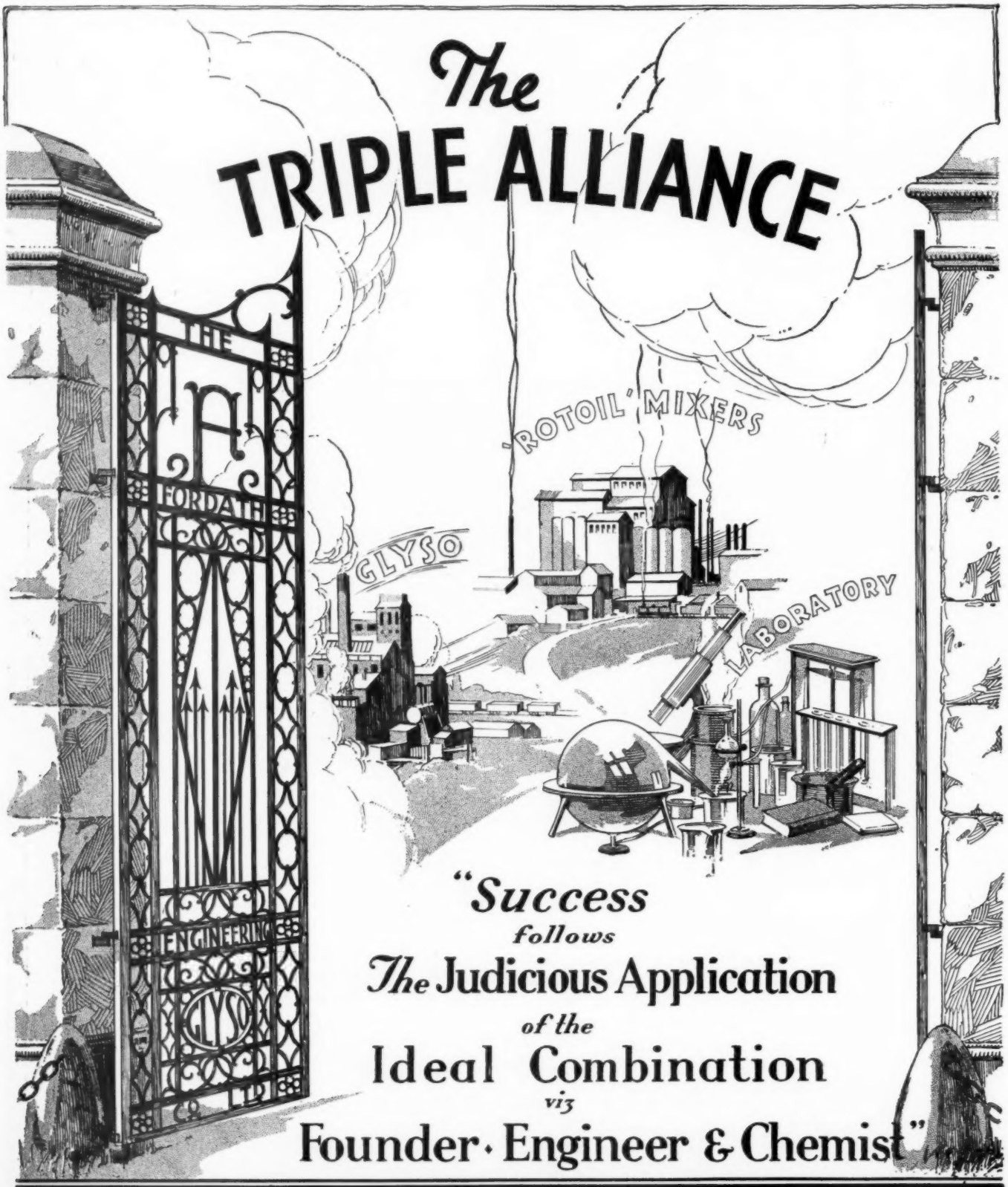

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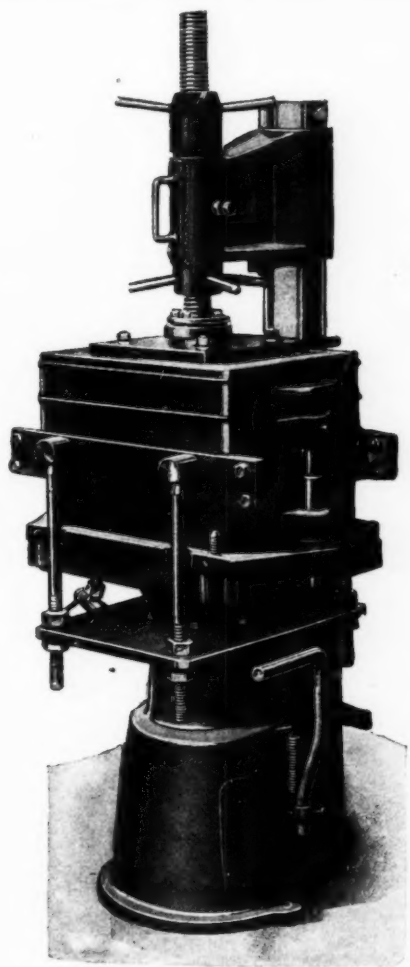

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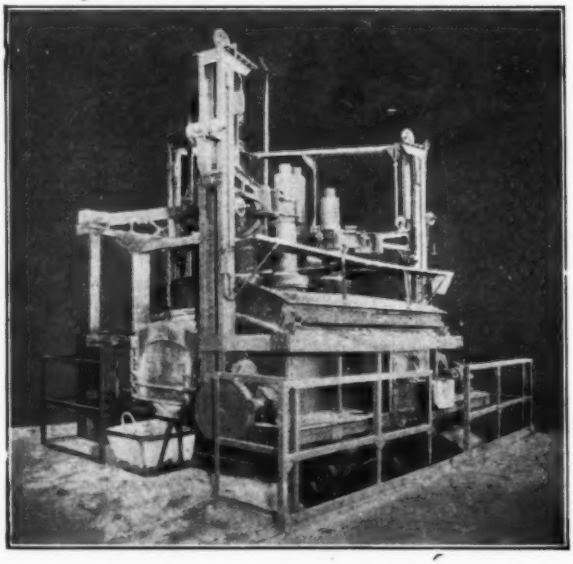

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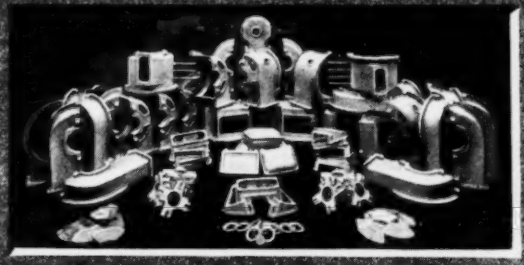

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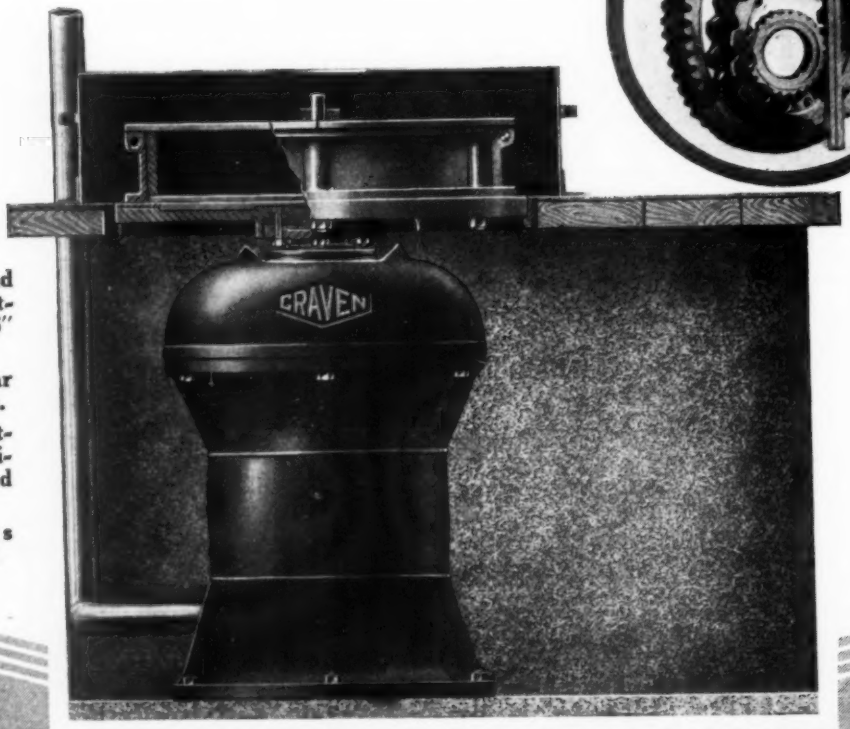

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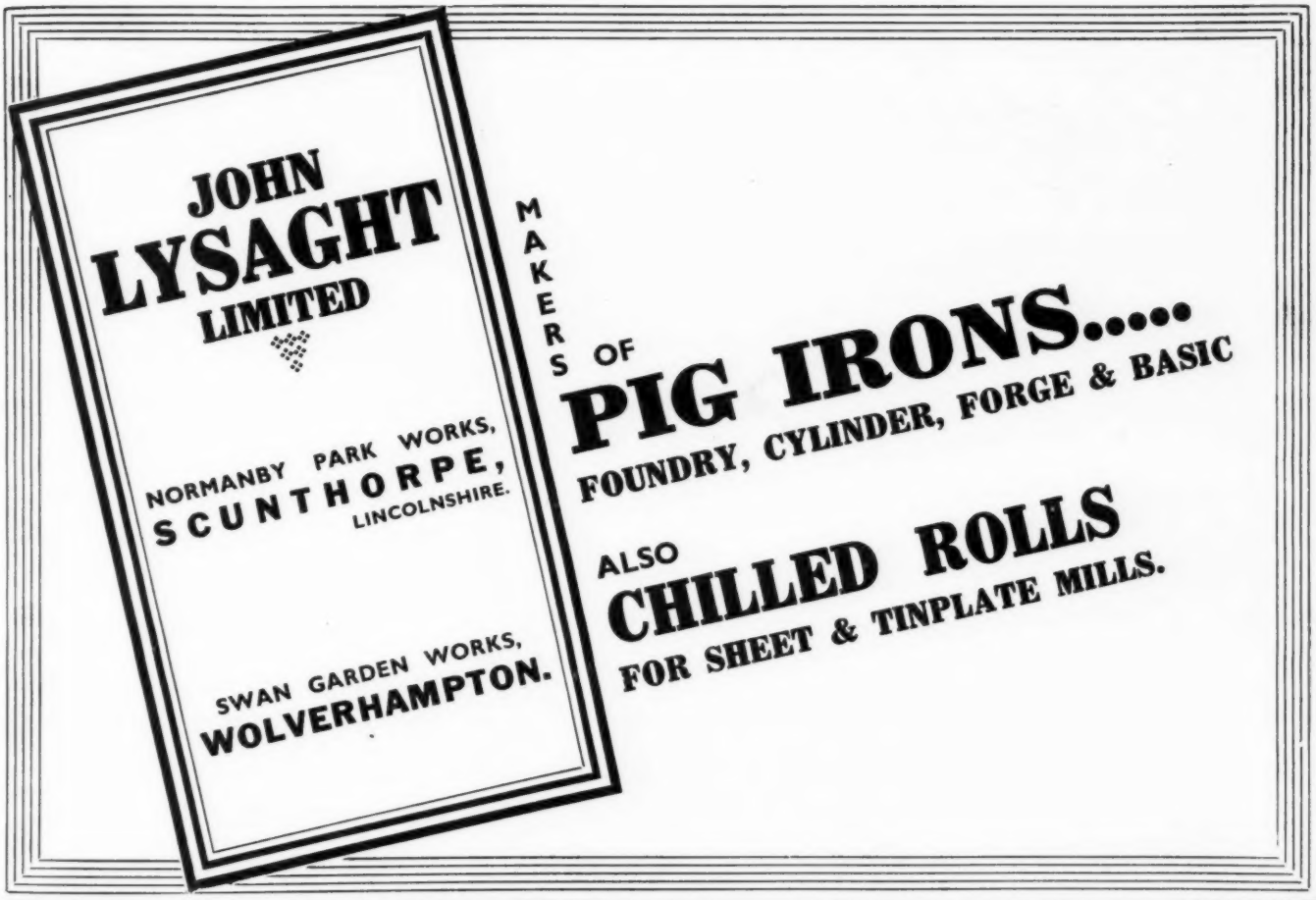

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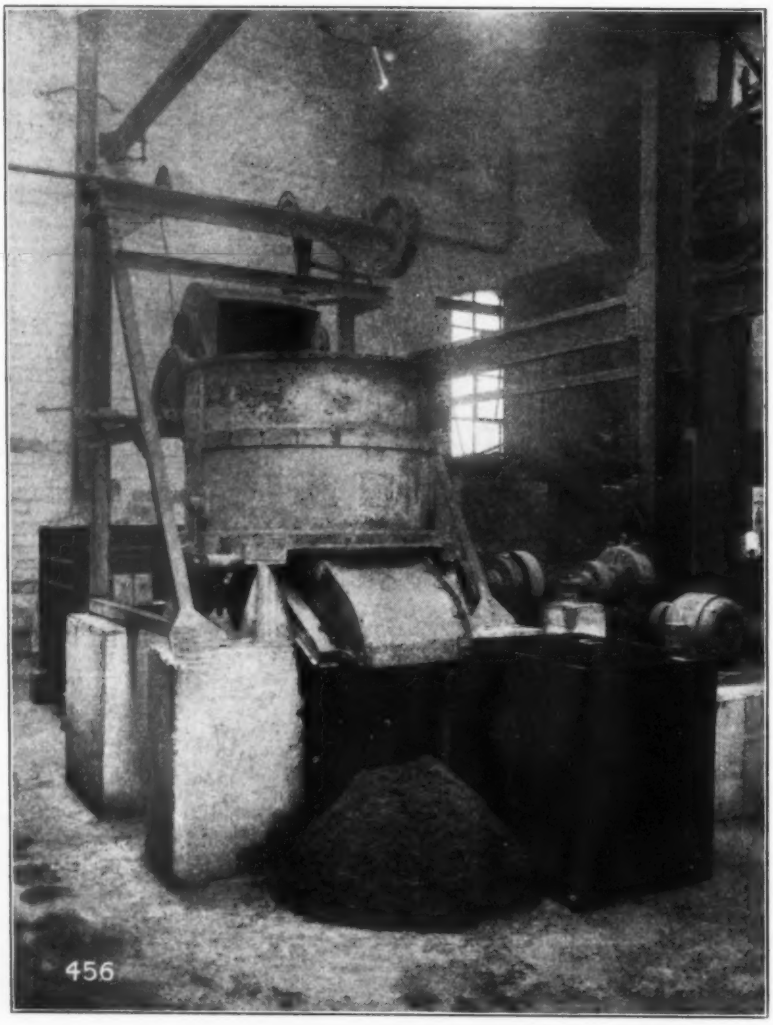

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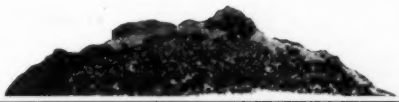
By the way—"Have you ever seen a secondhand Simpson?"

● "AUGUST'S" is the abbreviated title of *August's Muffle Furnaces Ltd.*, of Thorntree Works, King Cross, Halifax, England: A *British* firm of all *British* Capital, employing all *British* workpeople, and using none but all *British* materials. Furthermore, *August's* are *not* merchants but the actual manufacturers, and all *August's* plant is made completely and entirely in the Company's own works at Halifax, in Yorkshire.

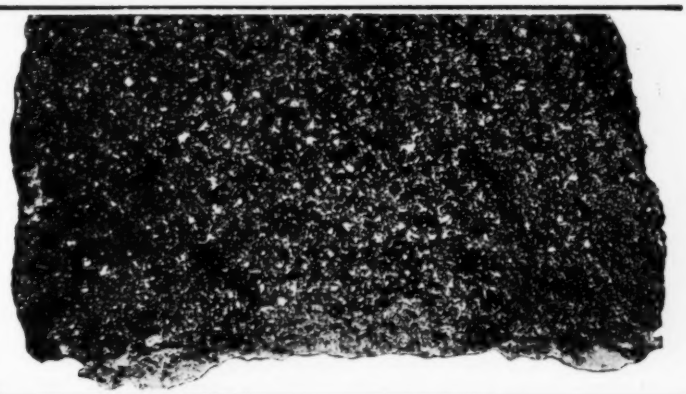


PIG IRON

MANUFACTURERS of Foundry, Basic and Hematite qualities.

Delivery from stock.

Booklet giving analyses, etc., will be sent on request.



DORMAN LONG

& COMPANY LIMITED, INCORPORATING
BOLCKOW VAUGHAN & CO. LTD., MIDDLESBROUGH

CHILLED ROLLS
TOUGH CASTINGS
LOCOMOTIVE CYLINDERS
AUTO-CYLINDER BLOCKS
MARINE ENGINES ETC
DIESEL ENGINE CASTINGS
HIGH DUTY

WARNER C·B·R

DEMAND HIGH GRADE PIG IRON
WARNER & CO., LIMITED.
CARGO FLEET · MIDDLESBROUGH.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	38	10	0
Three months	39	3	9
Electrolytic	46	0	0
Tough	39	10	0
Best selected	39	15	0
Sheets	77	0	0
India	57	0	0
Wire bars	49	5	0
Do., January	49	5	0
Do., February	49	5	0
Ingot bars	49	5	0
H.C. wire rods	49	15	0
Off. av. cash, Nov.	35	18	1½
Do., 3 mths., Nov.	36	9	10$\frac{3}{4}$
Do., Sttlmnt., Nov.	35	17	11½
Do., Electro, Nov.	42	1	2$\frac{3}{4}$
Do., B.S., Nov.	38	3	1½
Do., wire bars, Nov.	42	18	6$\frac{3}{4}$
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7½d.

BRASS.

Solid drawn tubes	10d.
Brazed tubes	12d.
Rods, drawn	8$\frac{3}{4}$d.
Rods, extd. or rlld.	5½d.
Sheets to 10 w.g.	8$\frac{3}{4}$d.
Wire	8½d.
Rolled metal	7$\frac{3}{4}$d.
Yellow metal rods	5½d.
Do. 4 × 4 Squares	6½d.
Do. 4 × 3 Sheets	6½d.

TIN.

	£	s.	d.
Standard cash	141	2	6
Three months	144	7	6
English	142	15	0
Bars	144	15	0
Straits	143	17	6
Australian	142	7	6
Eastern	147	7	6
Banca (nom.)	160	2	6
Off. av. cash, Nov.	132	18	10$\frac{3}{4}$
Do., 3 mths., Nov.	135	2	6
Do., Sttlmt., Nov.	132	17	10$\frac{3}{4}$

SPELTER.

	£	s.	d.
Ordinary	14	7	6
Remelted	13	5	0
Hard	11	5	0
Electro 99.9	16	12	6
English	15	2	6
India	13	10	0
Zinc dust	23	0	0
Zinc ashes	4	0	0
Off. aver., Nov.	14	0	10$\frac{3}{4}$
Aver. spot, Nov.	13	16	10$\frac{3}{4}$

LEAD.

	£	s.	d.
Soft foreign ppt.	15	11	3
English	17	0	0
Off. average, Nov.	14	10	8$\frac{3}{4}$
Average spot, Nov.	14	11	6$\frac{3}{4}$

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whf.	27	10	0
Rods	32	0	0
Boiler plates			—
Battery plates			—

ANTIMONY.

	£	s.	d.
Special brand, Eng.	40	0	0
Chinese	29	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	18	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£6 12 6
45/50%	£9 12 6
75%	£15 5 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free, 4/2, plus 55% per lb. Mo.	
Ferro-titanium—	
23/25% carbon-free	11½d. lb.
Ferro-phosphorus, 20/25%	£21 2 6
Ferro-tungsten—	
80/85%	1/8½ lb. plus 20%
Tungsten metal powder—	
98/99%	1/11½ lb. plus 20%
Ferro-chrome—	
2/4% car.	£34 0 0
4/6% car.	£24 12 6
6/8% car.	£23 10 0
8/10% car.	£22 12 6
Ferro-chrome—	
Max. 2% car.	£36 10 0
Max. 1% car.	£41 0 0
Max. 0.70% car.	£50 12 6
70%, carbon-free	11d. lb.
Nickel—99% (nom.)	£245 to £250
Ferro-cobalt	9/9 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£ 9 0 0
Metallic manganese—	
94/96% carbon-free	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	6	0 to	2	7	6
Bundled steel and shrngs.	1	17	6 to	2	6	6
Mixed iron and steel	2	2	0 to	2	3	6
Heavy cast iron				2	8	0
Good machinery for foundries	2	12	0 to	2	14	0
Cleveland—						
Heavy steel				2	2	6
Steel turnings	1	10	0 to	1	12	6
Cast-iron borings				1	6	0
Heavy forge				3	2	6
W.I. piling scrap				2	15	0
Cast-iron scrap	2	5	6 to	2	7	6
Midlands—						
Light cast-iron scrap				2	0	0
Heavy wrought				2	15	0
Steel turnings, f.o.r.				1	2	6
Scotland—						
Heavy steel				2	2	6
Ordinary cast iron				2	8	0
Engineers' turnings				1	10	0
Cast-iron borings				1	12	6
Wrought-iron piling				2	7	6
Heavy machinery				2	15	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	32	0	0
Brass	24	0	0
Lead (less usual draft)	12	10	0
Tea lead	9	10	0
Zinc	7	0	0
New aluminium cuttings	62	0	0
Braziery copper	30	0	0
Gunmetal	28	0	0
Hollow pewter	90	0	0
Shaped black pewter	70	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	65/6
Hematite M/Nos.	65/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	73/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	61/-
,, No. 3 fdry.*	66/-
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	57/6
,, fdry. No. 3*	62/6
,, fdry. No. 1*	65/6
Derbyshire forge*	61/-
,, fdry. No. 3*	66/-
,, fdry. No. 1*	69/-
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
,, No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	76/-
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/-
Clyde, No. 3	87/-
Monkland, No. 3	87/-
Summerlee, No. 3	87/-
Eglinton, No. 3	87/-
Gartsherrie, No. 3	87/-
Shotts, No. 3	87/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	15	0 to	10	0	0
Nut and bolt iron	8	7	6 to	8	12	6
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	10	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	15	0 to	9	15	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 15 0	& up.		
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	10	0
Black sheets, 24g.	8	0	0 to	9	0	0
Galv. cor. shts.	9	0	0 to	9	7	6
Galv. flat sheets	9	10	0 to	9	17	6
Galv. fencing wire, 8g. plain					—	
Billets, soft	5	7	6 to	5	12	6
Billets, hard				6	12	6
Sheet bars	5	0	0 to	5	5	0
Tin bars				5	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11½d.
Sheet to 10 w.g.	12½d.
Wire	12½d.
Rods	11½d.
Tubes	17d.
Castings	13d.

Delivery 3 cwt. free.

10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.

C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	15.51
No. 2 foundry, Valley	15.50
No. 2 foundry, Birm.	12.00
Basic	16.76
Bessemer	17.76
Malleable	17.76
Grey forge	17.51
Ferro-mang. 80%	75.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.55
Beams, etc.	1.50
Skelp, grooved steel	1.55
Skelp, sheared steel	1.55
Steel hoops	1.80
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	22/- to 25/-
,, furnace	16/6 to 17/6
Durham and Northumberland—	
,, foundry	15/- to 15/6
,, furnace	14/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	14/- to 14/6
,, 28×20 ,,	28/- to 29/-
,, 20×10 ,,	—
,, 18¾×14 ,,	—
C.W. 20×14 ,,	12/9
,, 28×20 ,,	25/3
,, 20×10 ,,	19/4½
,, 18¾×14 ,,	13/9

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars, hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.

[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Dec. 23 ..	38 11 3	dec.	37/6
,, 24 ..	39 2 6	inc.	11/3
,, 28 ..	39 3 9	,,	1/3
,, 29 ..	38 10 0	dec.	13/9
,, 30 ..	38 10 0	No change	

Electrolytic Copper.

	£ s. d.	
Dec. 23 ..	46 0 0	dec. 20/–
,, 24 ..	47 0 0	inc. 20/–
,, 28 ..	47 0 0	No change
,, 29 ..	46 0 0	dec. 20/–
,, 30 ..	46 0 0	No change

Standard Tin (cash).

	£ s. d.	
Dec. 23 ..	141 12 6	dec. 5/–
,, 24 ..	141 15 0	inc. 2/6
,, 28 ..	141 15 0	No change
,, 29 ..	141 2 6	dec. 12/6
,, 30 ..	141 2 6	No change

Tin (English ingots).

	£ s. d.	
Dec. 23 ..	143 5 0	No change
,, 24 ..	143 5 0	,, ,,
,, 28 ..	143 5 0	,, ,,
,, 29 ..	142 15 0	dec. 10/–
,, 30 ..	142 15 0	No change

Zinc Sheets (English).

	£ s. d.	
Dec. 23 ..	24 10 0	No change
,, 24 ..	24 10 0	,, ,,
,, 28 ..	24 10 0	,, ,,
,, 29 ..	24 10 0	,, ,,
,, 30 ..	24 10 0	,, ,,

Spelter (ordinary).

	£ s. d.	
Dec. 23 ..	14 11 3	dec. 3/9
,, 24 ..	14 11 3	No change
,, 28 ..	14 6 3	dec. 5/–
,, 29 ..	14 7 6	inc. 1/3
,, 30 ..	14 7 6	No change

Lead (English).

	£ s. d.	
Dec. 23 ..	16 15 0	No change
,, 24 ..	16 15 0	,, ,,
,, 28 ..	16 15 0	,, ,,
,, 29 ..	17 0 0	inc. 5/–
,, 30 ..	17 0 0	No change

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 0	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 0	0 16 6	0 16 0	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	Strike	Strike	Strike	Strike	Strike	Strike	Strike	1 5 0	(5 months) 1 1 1½
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS Moulder, unemployed, seeks engagement as Working Foundry Foreman; full knowledge of melting and mixing of aluminium, nickel, and all non-ferrous alloys; 23 years' practical experience in motor and engineering trades; Manchester district preferred.—Box 950, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WORKING FOREMAN wanted; small foundry specialising in finest machine castings, also non-ferrous work. Knowledge of blue-prints essential. Non-unionist; strict disciplinarian. Good references. State wages required.—Box 964, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

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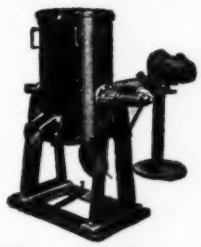

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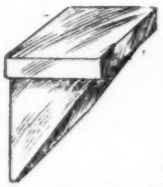

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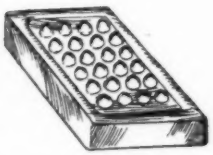

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